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Economics and the Environment: Trading Debt and Technology for Nature

Catherine A. O'Neill*
Cass R. Sunstein**

I. INTRODUCTION

In the last decade, the theory and practice of environmental protection have begun to incorporate principles of economics. New initiatives have attempted to protect natural resources while promoting economic development or at least minimizing adverse economic effects. Indeed, a staple of the recent movement for environmental reform has been attention to the costs and the unintended perverse effects of environmental regulation. It has been shown, for example, that centralized command-and-control regulation can discourage innovation in pollution control, increase rather than decrease pollution levels, freeze existing technology, and produce serious inefficiencies in the form of unnecessarily high costs.¹

Understandings of this sort have led environmental reformers close to the principle of Pareto superiority, encompassed in strategies that can make people better off without making anyone worse off,² or at least anyone who has a basis for legitimate complaint. Thus, for example, systems in which polluters pay for the harms they cause, and are permitted to purchase and sell the resulting permits, are preferable to the currently pervasive "best

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1. See Ralph Turvey, *On Divergence Between the Social Costs and Private Costs*, in *ECONOMICS OF THE ENVIRONMENT* 187-91 (Robert Dorfman & Nancy S. Dorfman eds., 1977); Allen V. Kneese & Blair T. Bower, *Standards, Changes and Equity*, in *ECONOMICS OF THE ENVIRONMENT*, *supra*, at 217-28; Bruce A. Ackerman & Richard B. Stewart, *Reforming Environmental Law: The Democratic Case for Market Incentives*, 13 COLUM. J. ENVTL. L. 171 (1988).

2. See RICHARD A. POSNER, *ECONOMIC ANALYSIS OF LAW* 12-14 (1986).

available technology" requirements along every possible dimension of social welfare.³ The general use of the principle that "polluters pay," combined with other decentralized, incentive-based strategies, holds out far more promise for environmental reform than the technology-based strategies of the last two decades.

Similar debates have begun to arise in the international arena, which promises to be the focal point for environmental policy in the next generation. Some people have suggested, for example, that the greenhouse effect⁴ and the destruction of the ozone layer⁵ might be controlled through the imposition, by treaty, of uniform technological requirements on sources of environmental pollutants, or of strict emissions limits laid down in advance by some international body.⁶ Protection of endangered species might involve the adoption by all nations of uniform measures for controlling action threatening to endangered populations.⁷ Indeed, there has been considerable movement in these directions, as nations start to develop coordinated strategies for handling what are, after all, global problems.⁸

At first glance there seems much to be said on behalf of uniform strategies for handling international environmental problems. Since such strategies appear to treat everyone alike, they seem to have the important virtues of ease of application and

3. See Ackerman & Stewart, *supra* note 1, at 172.

4. This phenomenon, sometimes described as global warming, is produced by accumulation of carbon dioxide and other gases in the atmosphere. See JOHN FIROR, *THE CHANGING ATMOSPHERE: A GLOBAL CHALLENGE* 49-55 (1990); MICHAEL OPPENHEIMER & ROBERT H. BOYLE, *DEAD HEAT: THE RACE AGAINST THE GREENHOUSE EFFECT* 22-33 (1989).

5. This phenomenon is produced mostly by chemicals called chlorofluorocarbons ("CFCs"). See FIROR, *supra* note 4, at 26-43.

6. International efforts and proposals to date have generally favored uniform requirements. See, e.g., Montreal Protocol on Substances That Deplete the Ozone Layer, Sept. 16, 1987, 26 I.L.M. 1550 (entered into force Jan. 1, 1989) (calling for phasing out CFC production). Some international agreements, however, are beginning to make some provision for the situation of developing countries, by permitting at least a longer time period within which those countries must meet specific levels or standards. See, e.g., *id.* art. 5, 26 I.L.M. at 1555-56.

7. See, e.g., Convention on International Trade in Endangered Species of Wild Fauna and Flora, Mar. 3, 1973, 27 U.S.T. 1087 (entered into force July 1, 1975).

8. See generally Hilary F. French, *Strengthening Global Environmental Governance*, in *STATE OF THE WORLD 1992*, at 155 (Lester R. Brown ed., Worldwatch Institute 1992). See also the discussion of efforts toward worldwide reduction targets for carbon dioxide, in *UNCED Meeting, Ozone-Depleting Substances Top Environmental Agenda for 1992*, 15 Int'l Envtl. Rep. (BNA) 54 (Jan. 29, 1992). Negotiations are currently underway for proposed international agreements on forestry, biodiversity, and climate change, in conjunction with the June 1992 United Nations Conference on Environment and Development.

general equity. But there are enormous disparities among nations in terms of standard of living, patterns of consumption, and past contribution to present problems. Differences exist as well in natural resource endowments, in technological capacities, and in social and cultural values.

In view of these differences, international solutions that impose uniform obligations are both inefficient and unjust. Uniform regulations are likely to impose costs far in excess of those necessary to achieve the relevant goals and even to frustrate achievement of these goals.⁹ Such regulations also confer disproportionate benefits on nations that have gained from their existing contributions to current problems, and they impose disproportionate burdens on nations that have the least to lose from increased environmental degradation. It should be unsurprising that poor countries have been especially reluctant to enter into agreements that seem to intrude on their sovereignty while imposing costs that dwarf the potential benefits.¹⁰

In both developing and industrialized nations, any strategy designed to address global environmental problems must at the same time confront the issues of poverty and economic development, which often seem to make environmental protection a luxury that most nations cannot afford. Until recently, these tandem concerns have been compartmentalized and considered separately by agencies and institutions charged with one mission or the other.¹¹ There is an emerging consensus that recognition of

9. See Ackerman & Stewart, *supra* note 1, at 173-75; Cass R. Sunstein, *Administrative Substantance*, 1991 DUKE L.J. 607, 627-31.

10. See French, *supra* note 8, at 160-61 (noting that the fund to help developing countries make the transition to CFC substitutes was central to treaty on ozone depletion, the Montreal Protocol).

11. In the mid-1980s, some international development institutions were instructed to consider the environmental impact of the decisions they made within their discrete area of competence. But environmental and economic concerns were still largely treated as distinct. Initiatives by international environmental entities, too, have only recently begun to reflect the connection between the issues of environment and development. In May, 1987, for example, the President of the World Bank announced that the World Bank would address the environmental aspects of development projects. Shortly thereafter, the World Bank undertook internal restructuring, including the creation of a central Environmental Department, designed to increase the integration of environmental considerations in all stages of project financing. More recently, the World Bank has indicated that environmental impact assessment statements will become a standard requirement of project proposals. See generally Darryl Joannides, Note, *Restructuring the World Bank: The Environmental Light Shines on the Funding of Development Projects*, 2 GEO. INT'L ENVTL. L. REV. 161 (1989). Moreover, governmental development assistance efforts have recently strengthened their re-

the global nature of environmental problems necessarily entails recognition of the global nature of the problems of poverty and development.¹² While this theoretical consensus is important, international policy has yet to reflect the interrelation between environment and development. The challenge for international cooperative efforts is to put this recognition into practice.

The rallying cry of "sustainability"¹³ is a shorthand description of the need to integrate considerations of environmental quality and economic development. The underlying goal of sustainability is Paretian in character: the simultaneous improvement of the welfare of multiple groups and interests, including those of future generations.

Nowhere is there a greater need to adopt sustainability and Paretianism as guiding maxims for policy than for those environmental issues that involve the interests of both developed and developing countries. It is clear that countries of the Third World must be free to pursue development and improve prospects for economic health and self-determination. In order to reduce poverty and unemployment, and to eliminate the large international debt burden under which many developing countries now operate, new productive arrangements are indispensable. Equally clear, however, is the need for growth to be undertaken in an ecologically prudent manner, that is, in a manner appreciative of the fact that neither economic nor environmental health can be realized in isolation.

quirement of environmental impact assessments. See WORLD RESOURCES INSTITUTE, NATURAL ENDOWMENTS: FINANCING RESOURCE CONSERVATION FOR DEVELOPMENT § 2.1, at 5-6 (International Conservation Financing Project Report 1989) [hereinafter NATURAL ENDOWMENTS].

Development assistance agencies rely primarily upon economists and engineers for project preparation. In the past environmental concerns often received attention as an afterthought. See *id.* at 6. Thus, despite international policy guidelines, "[t]here is still a potentially dangerous tendency within many of these institutions to compartmentalize environmental issues, and, in effect, treat them as peripheral to crucial macroeconomic adjustment issues when, in many developing countries, they are indeed central." *Id.* at 21.

12. Consider, for example, the embodiment of this recognition through the inclusion, in 1992, of development among the aims of the United Nations Conference on Environment and Development; its predecessor, the United Nations Conference on the Human Environment, declined to take this step in 1972. See *infra* note 171. See also H. Jeffrey Leonard & David Morell, *Emergence of Environmental Concern in Developing Countries: A Political Perspective*, 17 STAN. J. INT'L L. 281 (1981).

13. See WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT, OUR COMMON FUTURE 8-9 (1987); LESTER R. BROWN, BUILDING A SUSTAINABLE SOCIETY (1981).

Ecological prudence did not, of course, characterize the methods by which developed nations achieved economic growth and prominence during the industrial revolution; nor does it characterize the consumption patterns of most of the developed world today. It is a hard question whether and to what extent the industrialized nations are now obligated to their less-developed counterparts for having produced global environmental degradation, but it is clear that in their future development, all nations must avoid repeating the mistakes of the past.

In recent years, the "debt-for-nature" swap has become a prominent strategy for solving environmental problems within the frameworks of sustainability and Paretianism. Broadly speaking, debt-for-nature swaps are designed to stem the exploitation of natural resources in developing nations without ignoring economic needs in those nations.¹⁴ Their chief virtue is that they confer economic benefits while promoting environmental goals. But it is necessary to develop more ambitious arrangements for achieving environmental quality and economic growth.

In this Article we have two goals. The first is to explore and suggest improvements in current debt-for-nature swaps, with the ultimate aim of defending the use of economic incentives and Paretian principles in the context of international environmental policy. The second is to examine some of the limitations of the exchange of debt for nature, and thus to suggest an alternative exchange that overcomes those limitations. The exchange we envision is quite simple. Developed nations would transfer¹⁵ to developing nations environmentally advanced technologies, particularly technologies designed to increase efficient energy use or to replace non-renewable sources with renewable sources of energy. In return, developing nations would agree to provide a measure of environmental protection.

14. A generic formulation requires this level of generality. As will be discussed, a broad spectrum of arrangements have been or could be fashioned. In particular, the vagueness of the phrase "without *ignoring* their economic needs" is warranted because some arrangements merely refrain from exacerbating the underdeveloped condition of the nation's economy while others could actually advance, to varying degrees, the development of the nation.

15. The term "transfer" is employed loosely to refer to a number of arrangements, ranging from donation to cooperation, the best among which would be those that involve joint research efforts enhancing the developing nation's capacity to conduct independent research and achieve technical self-reliance.

In Part II of this Article, we outline the concerns, both ecological and economic, that lead to the creation of debt-for-nature swaps. In Part III, after detailing the mechanics of such swaps, we discuss various objections to these exchanges and examine potential limitations on their usefulness. In Part IV, we discuss the current possibilities for the implementation of technologies for the efficient use of energy and for the development of renewable sources of energy. We then propose an exchange of such technologies for nature and note several considerations that will bear upon the structuring of such trades.

We conclude that trades of energy technology for nature have significant advantages over debt-for-nature swaps. Trades that involve technology hold out the best long-term promise for helping both developing and industrialized nations to promote economic development, to protect the environment, and to bring about an equitable international sharing of the burdens imposed by both of these imperatives.

II. PROBLEMS GIVING RISE TO DEBT-FOR-NATURE SWAPS

We begin by describing the pressures that have made exchanges of debt for nature so attractive to a seemingly disparate array of parties. These pressures include extreme stresses on the natural resources of developing countries — stresses that have created environmental risks for those countries and for the world as a whole — and mounting international debt.

A. *Environmental Concerns*

The immediate need for economic progress in developing countries has led to severe environmental degradation. A major problem is deforestation. The razing of the world's rain forests continues at an alarming rate. In 1990 alone, seventeen million hectares of tropical forest were destroyed.¹⁶ Only half of the world's mature tropical forests still exist.¹⁷

Eighty percent of the forests of the Philippine archipelago have been destroyed; Haiti, India, Sri Lanka, El Salvador, Ghana, Nigeria, and Bangladesh have lost all or nearly all of their primary rain

16. John C. Ryan, *Conserving Biological Diversity*, in STATE OF THE WORLD 1992, *supra* note 8, at 9, 10.

17. GEOFFREY LEAN ET AL., ATLAS OF THE ENVIRONMENT 65 (1990).

forest; Honduras will have lost more than half by the year 2000.¹⁸ Latin America has lost thirty-seven percent of its tropical forests and Africa has lost fifty-two percent.¹⁹ If the current rate of net deforestation persists, the world will lose an area more than half the size of the continental United States by the year 2030,²⁰ and tropical forests will be virtually eliminated within the next eighty-five years.²¹

Many developing country governments have actively encouraged colonization of rain forests to relieve population pressures, distribute land to the poor, and promote development. A particularly revealing example is the policy of the Amazonas government to issue free chain saws to colonizers.²² Expenditure and taxing policies have encouraged deforestation in the Amazon region and elsewhere in the developing world.²³ An estimated \$1 billion worth of timber was burned in the Brazilian Amazon in a single year, in part stimulated by government policies such as subsidizing cattle ranches.²⁴

The environmental consequences of deforestation are complex, but there can be no doubt that the consequences are potentially great. Some of these effects are immediately observable; others depend upon poorly understood ecological, geographical, and temporal interrelationships. It is clear, for example, that deforestation threatens genetic diversity. The rain forests are an extraordinary source of species of animals and plants, holding at

18. *Id.* at 65-67.

19. *Id.* at 65.

20. See Lester R. Brown et al., *Picturing a Sustainable Society*, in STATE OF THE WORLD 1990, at 173, 184 (Lester R. Brown ed., Worldwatch Institute 1990).

21. JOSE GOLDEMBERG ET AL., ENERGY FOR A SUSTAINABLE WORLD 40 (1988).

22. See Michel Bird, *But Will Amazon Jungle Survive the Onslaught*, TORONTO GLOBE & MAIL, Nov. 15, 1989, at A7.

23. See generally MALCOLM GILLIS & ROBERT REPETTO, DEFORESTATION AND GOVERNMENT POLICY (1988).

24. See NATURAL ENDOWMENTS, *supra* note 11, at 18 n.26. See also WORLD BANK, WORLD DEVELOPMENT REPORT 1990, at 59, Box 4.1 (1990) [hereinafter WORLD DEVELOPMENT REPORT 1990]. Note that new governmental policies have in turn played a major role in lowering the rate of destruction of the rain forest in Brazil. The recent elimination of most of the tax credits encouraging deforestation has contributed to the decline in deforestation in the Brazilian Amazon from 8 million hectares in 1987 to 3 million hectares in 1989. Although the 1989 figure may be explained in part by the unusual amount of rainfall during the dry season (during which most of the burning takes place) and by increased enforcement efforts against illegal burning, the dismantling of financial incentives appears to have contributed significantly to the fairly rapid change in trends. See Sandra Postel & Christopher Flavin, *Reshaping the Global Economy*, in STATE OF THE WORLD 1991, at 178 (Lester R. Brown ed., Worldwatch Institute 1991).

least half of the earth's species despite occupying only six percent of its land area.²⁵ A single volcano in the Philippines has more kinds of woody plants than all of the United States.²⁶ Elimination of species may in turn have a variety of harmful effects, including the reduction of available genetic stock for development of medicines and wild strains that reduce plant disease. The medicinal and agricultural losses could be both enormous and irreversible. This is a concern quite independent of the possible ethical obligation of one species not to produce wholesale extinctions of others, or to contribute to massive deaths of other living creatures.

Deforestation contributes to the problem of climate change in several ways. The most obvious impact, caused by the very act of felling and burning trees, is the release of carbon directly into the atmosphere. Recent estimates attribute the release of one to two billion tons of carbon per year to deforestation.²⁷ By comparison, in 1988, the combustion of fossil fuels released 5.66 billion tons of carbon into the atmosphere.²⁸ Although developing countries use fossil fuels at a much lower rate than do their industrialized counterparts, their contribution to the world's total carbon emissions is significant. Deforestation in Brazil alone accounts for the release of 336 million tons of carbon annually.²⁹ This amount is nearly six times its contribution of carbon from fossil fuel combustion. The combination of these two sources, however, makes Brazil the fourth largest carbon emitter in the world.³⁰ Deforestation also accounts for Indonesia's and Colombia's place among the world's ten largest carbon emitters.³¹

In addition to the direct release of carbon into the atmosphere, large-scale deforestation contributes to perturbations in the global carbon cycle and ultimately to the risk of climate change. Destruction of trees eliminates a major source of carbon uptake, because trees act as a natural "sink" that absorbs carbon rather

25. Edward O. Wilson, *Threats to Biodiversity*, in *MANAGING PLANET EARTH* 49, 51 (1990).

26. LEAN ET AL., *supra* note 17, at 68.

27. See Christopher Flavin, *Slowing Global Warming*, in *STATE OF THE WORLD 1990*, *supra* note 20, at 17, 18.

28. *Id.* at 18.

29. *Id.* at 20-21 & Table 2-2.

30. *Id.* at 20-21.

31. *Id.*

than allowing it to move into the atmosphere.³² Other disturbances, more difficult to quantify, also result from deforestation. Changes in terrain reflectivity after forests have been cleared affect the hydrological cycle, producing variations in precipitation, evaporation, and runoff. These changes may in turn have effects on atmospheric circulation and climate.³³

The destruction of protective forest cover also threatens to increase soil erosion, undermining the capacity of the land to support agricultural and other productive uses. As a consequence of deforestation and the resulting soil erosion, an estimated one-tenth of the world's crop lands — an area equivalent to the size of the United States — can no longer sustain cultivation.³⁴ In addition, increased runoff clogs water systems with silt, and produces flooding in some areas.³⁵ Soil erosion may lead, in the extreme, to desertification. According to United Nations Environment Programme estimates, worldwide losses in agricultural production from desertification total \$26 billion per year.³⁶

Deforestation is hardly the only relevant environmental concern for developing nations. Economic development in such nations depends in large part on the use of energy, and much of the global increase in energy use will come from this part of the world.³⁷ If developing countries need and use the energy sources characteristic of industrialized nations, the environmental consequences will be enormous.³⁸ Carbon dioxide emissions from developing countries are currently increasing at a rate of six percent per year. By contrast, in Western Europe and North America, the

32. See INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE: THE IPCC SCIENTIFIC ASSESSMENT 7-18 (J.T. Houghton et al. eds., 1990) (technical discussion of carbon flux, the effects of various carbon emissions on the carbon cycle, and their contribution to the risk of climate change) [hereinafter IPCC REPORT].

33. *Id.* at xxxii.

34. Lester R. Brown & Edward C. Wolf, *Reclaiming the Future*, in STATE OF THE WORLD 1988, at 170, 174 (Lester R. Brown ed., Worldwatch Institute 1988).

35. GOLDBERG ET AL., *supra* note 21, at 40.

36. See NATURAL ENDOWMENTS, *supra* note 11, at 2 (citing YUSUF J. AHMAD & MOHAMED KASSAS, DESERTIFICATION: FINANCIAL SUPPORT FOR THE BIOSPHERE (1987)).

37. See Christopher Flavin, *Building a Bridge to Sustainable Energy*, in STATE OF THE WORLD 1992, *supra* note 8, at 27, 30.

38. The consumption pattern of the industrialized world, which accounts for $\frac{2}{3}$ of global energy use, is carbon intensive. See GOLDBERG ET AL., *supra* note 21, at 22. In Organization for Economic Cooperation and Development ("OECD") countries in 1989, for example, fossil fuels contributed 84.5% to total primary energy consumption. Calculation based on BRITISH PETROLEUM COMPANY, BP STATISTICAL REVIEW OF WORLD ENERGY 34 (June 1990).

rate of increase of carbon dioxide emissions fell from about three percent per year in the period 1945 to 1972, to less than one percent per year in the period 1973 to 1984.³⁹ By 2010, the developing world might well account for half of the world's carbon emissions.⁴⁰

In absolute terms, fossil fuel combustion still occurs in relatively small amounts in developing countries, but it is increasing.⁴¹ China is now the world's third largest source of carbon emissions, and it will soon surpass the status of the former Soviet Union.⁴² Even if developing countries sought only to engage in existing carbon-emitting activities, their growing populations would require substantial increases in the amount of carbon emitted.⁴³ Efforts to achieve economic growth have typically required increased energy consumption, and thus greater levels of carbon emissions.⁴⁴ The combustion of fossil fuels contributes not only to the greenhouse effect, but also to a wide range of other pollution problems, including acid deposition, which damages crops and forests.

While this description of environmental problems in developing countries is incomplete, it helps explain why debt-for-nature exchanges might be attractive to developing and industrialized countries alike. We now turn to the economic concerns that lie behind these exchanges.

39. IPCC REPORT, *supra* note 32, at 10. For further discussion of the interaction of numerous national and global events explaining the trends in industrialized country emissions, see Flavin, *supra* note 27, at 20. For a description of the factors accounting for the increasing rate of carbon dioxide emissions in developing countries, see *id.* at 20-21; IPCC REPORT, *supra* note 32, at 10-11. Particularly troubling is the suggestion that the rate of growth of fossil fuel use in developing countries has been constrained in large part by economic problems such as the debt crisis. If this is so, dramatic increases in fossil fuel use might be expected to ensue upon solution of these problems. Flavin, *supra* note 27, at 20.

40. Flavin, *supra* note 37, at 30.

41. See Flavin, *supra* note 27, at 20; GOLDBERG ET AL., *supra* note 21, at 191 (noting that the 70% of humanity living in developing countries accounts for less than 20% of world fossil fuel consumption).

42. Flavin, *supra* note 37, at 30.

43. The average woman in industrialized nations bears two children, whereas her counterpart in the Middle East and Africa has between six and eight. The result is that more than 90% of the world's population growth is occurring in the developing world. LEAN ET AL., *supra* note 17, at 17.

44. Recent development efforts in such rapidly expanding economies as South Korea have relied heavily upon an increased use of fossil fuels, lending credence to concerns that economic development will be pursued along environmentally threatening lines. See Flavin, *supra* note 27, at 20.

B. *Economic Concerns*

Less developed nations face the general challenge of economic growth. One of the most difficult aspects of the quest for growth is the continuing accumulation of foreign debt. The cumulative foreign debt of developing countries was estimated to be \$1.34 trillion in 1990, and it is increasing.⁴⁵ While the amount owed by the severely indebted low-income countries is not, in absolute terms, as great as that owed by the severely indebted middle-income countries, the burden on the economies of the low-income countries is especially serious.⁴⁶ As one indicator of this stress, the ratio of debt to gross national product was recently 111% for the low-income countries.⁴⁷ Debt service exacts a heavy toll on the economies of debtor nations.⁴⁸ In 1988, interest payments alone on long-term foreign debt amounted to \$60 billion.⁴⁹ Since 1982, Latin American countries have sent a net total of \$220 billion in capital to creditor nations. Most of that money consists of payments of principal and interest on foreign debt.⁵⁰ Despite the payment by developing countries of billions of dollars in principal and interest by the year 1988,⁵¹ the debt has continued to mount, totalling \$1.3 trillion in 1991.⁵²

Because of the debt problem, the traditional net flow of capital from industrialized to developing nations was reversed in 1982, and transfers in the other direction are steadily increasing.⁵³ In

45. See Melvyn Westlake, *Recession Puts the Brakes on Recovery*, THE GUARDIAN (int'l ed.), Feb. 4, 1991, at 12 (discussing the continuing increase in the cumulative debt burden and the recent reversal of progress made since 1988) [hereinafter Westlake I].

46. The foreign debt of the 26 severely indebted low-income countries, the majority of which are in sub-Saharan Africa, is \$116 billion. The foreign debt owed by the 20 severely indebted middle-income countries, the bulk of which comprise Latin America, is \$590 billion. The remainder of the \$1.34 trillion figure is accounted for by countries with less acute debt problems. *Id.*; Melvyn Westlake, *The Continent that Suffers in Silence*, THE GUARDIAN (int'l ed.), Feb. 5, 1991, at 13 [hereinafter Westlake II].

47. WORLD DEVELOPMENT REPORT 1990, *supra* note 24, at 126.

48. See *id.* at 222-23, Table 23 (conventional indicators of the ability of developing countries to support the burdens of servicing their debt, expressed both as a ratio of debt service to exports and as a ratio of debt service to GNP).

49. Calculation of this figure based on *id.*

50. See Westlake I, *supra* note 45, at 12.

51. See WORLD DEVELOPMENT REPORT 1990, *supra* note 24, at 222-23, Table 23.

52. WORLD BANK, WORLD DEVELOPMENT REPORT 1991, at 24 (1991).

53. For a discussion of the history of the debt crisis, see Christine A. Bogdanowicz-Bindert & Richard E. Feinberg, *Third World Debt: An Analysis* (Feb. 1988) (unpublished paper, available from the World Wildlife Fund, Washington, D.C.). See also Michael Chamberlin et al., *Sovereign Debt Exchanges*, 1988 U. ILL. L. REV. 415, 415 & nn.1-4.

the early 1980s, poor countries received a \$40 billion per year surplus from rich countries; by 1988, they were sending back many billions more to service their debts.⁵⁴ It is fully plausible that debt is the most urgent problem confronting developing nations in the world today. Above all, the problem is that debts must be paid before these nations can shift their efforts to economic and social development.

A particular difficulty is that the existence of foreign debt increases the pressure on developing countries to exploit their natural resources, and to do so quickly. The use of natural resources may provide the simplest way to obtain the funds necessary to pay off debts. Such resources as waters, parks, soils, and forests are the principal economic assets in these nations. Indeed, at the urging of the finance ministries of creditor nations and international agencies such as the World Bank and the International Monetary Fund ("IMF"), many debtor nations have fashioned economic adjustment programs that revolve around efforts to increase exports.⁵⁵ Since primary commodities (non-manufactured goods) comprise a substantial share of exports from most severely indebted countries, strategies of this kind tax the natural resources of these countries and threaten the long-term viability of their resource-based economies.⁵⁶ The irony is that long-term development requires measures that preserve an adequate stock of natural resources for local use and export in forestry, agriculture, fishing, and tourism, among others; these are precisely the measures endangered by current export strategies.

In Latin America in particular, the need to obtain funds to meet debt obligations has put an immense amount of pressure on ecological systems. The resulting policy has been to do little to combat domestic problems while encouraging the export of natural resources to developed countries at a rate that prevents the sustainable use of those resources.⁵⁷ The environmental resources

54. LEAN ET AL., *supra* note 17, at 44.

55. See Westlake 1, *supra* note 45, at 12.

56. In 1987 to 1988, primary, nonfuel commodities comprised 39.3% of exports from severely indebted middle-income countries and 52.5% of exports from severely indebted low-income countries. WORLD DEVELOPMENT REPORT 1990, *supra* note 24, at 20, Table 1.4. Current price trends, moreover, threaten to exacerbate this dynamic. If the 33% decline in commodity prices from 1980 to 1989 continues, developing countries may seek to export increasing quantities of commodities to obtain the same amount of revenue. *Id.* at 13.

57. See WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT, *supra* note 13, at 6, 73-75.

of developing countries have thus been under severe strain. Ethiopia's forest cover, for example, has diminished from 30% to 1% of its territory and India's from over 50% to less than 14%.⁵⁸ In Africa, twenty-nine trees are cut down for every one that is planted.⁵⁹ The result of the exploitation of existing resources, made necessary in part by debt burdens, is reduction in the stock of environmental capital, which increases rates of poverty, hunger, and death.⁶⁰

There are plausible arguments that, for various reasons, the debt owed by developing countries should be forgiven or in some sense relieved or repudiated. We have seen that the existence of debt imposes environmental burdens on developing countries, burdens that produce risks for developed countries as well. For this reason it is possible that debt forgiveness is in the interest of all nations. There are a number of other justifications for relief. In Latin America, for example, borrowing has been undertaken by military governments without a solid connection to the citizenry, with the purpose of providing for massive arms spending or permitting capital flight.⁶¹ Debt might be forgiven when it is unclear if the leaders who incurred debts had legitimate authority to act on behalf of their countries; perhaps citizens in these countries should not be obligated to pay debts that were not a product of any plausible conception of consent or mutual benefit.

The dramatic increases in the expense and difficulty of debt servicing may be attributable to circumstances that were not and could not have been anticipated by debtor nations. For example, real interest rates increased from zero or negative in the 1970s to more than eight percent under the United States price index in the early 1980s.⁶² This increase in the burden of debt interest service, which had no historical antecedents, was accompanied by an increase in the value of the dollar, in which most debt is de-

58. See Jim MacNeill, *Strategies for Sustainable Economic Development*, in *MANAGING PLANET EARTH* 108, 112-13 (1990).

59. *Id.* at 113.

60. See generally DAVID PEARCE ET AL., *SUSTAINABLE DEVELOPMENT: ECONOMICS AND ENVIRONMENT IN THE THIRD WORLD* (1990).

61. See John Williamson, *The Outlook for Debt Relief or Repudiation in Latin America*, 2 *OXFORD REV. ECON. POL.* 1, 4 (1986).

62. Real interest rates climbed as high as 9% in mid-1981, while they had been as low as -3% in 1975. Even the average of the years 1980 to 1989, at 5.85%, was nearly six times the average of the years 1974 to 1979 — when the developing countries took on a large portion of their debt — at 0.97%. *WORLD DEVELOPMENT REPORT 1990*, *supra* note 24, at 14-15 & Fig. 1.6.

nominated. The various increases were a function of shifts in the policies of industrialized nations, and they were aggravated by IMF policies raising the costs faced by debtors.⁶³ On this view, industrialized nations are now under an obligation to undertake debt relief.

There are other arguments for relief as well. As we have seen, foreign debt imposes a crippling burden on developing countries. This burden has been an obstacle to both internal development and environmental protection. The result is considerable international distrust and ill will as well as domestic instability. The existence of large debts has thus imposed severe pressure on the global economic system. It has also required poor countries to spend so much money on the servicing of loans that they are unable to pay for imported goods.⁶⁴ As many as six million jobs may have been lost in the developed world because of the debt crisis.⁶⁵ These arguments suggest that debt cancellation might increase international harmony, help the export capacities of developing nations, eliminate a crucial reason for environmental degradation, and operate as a mutually beneficial form of foreign aid.⁶⁶

We do not seek to evaluate these claims here. Among the obvious difficulties in any large-scale debt relief program are: the problem of determining whether, *ex ante* or *ex post*, any government has a legitimate claim to act on behalf of its citizenry; the potential unfairness to creditors of permitting resources loaned to developing nations to disappear; and the possibility that debt relief or repudiation will in the end harm developing countries by discouraging creditors from offering loans to them in the first in-

63. *Id.* at 15; LEAN ET AL., *supra* note 17, at 44.

64. See George C. Abbott, *The Case for Cancellation*, 1975 *INTERECONOMICS* 217, 220. For the view that coordinated debt forgiveness can sometimes benefit all sides, see Kenneth A. Froot, *Buybacks, Exit Bonds, and the Optimality of Debt and Liquidity Relief*, 30 *INT'L ECON. REV.* 49 (1989).

65. See LEAN ET AL., *supra* note 17, at 44.

66. For a discussion emphasizing the benefits to creditor nations of taking on some of the debtors' burdens, see Bogdanowicz-Bindert & Feinberg, *supra* note 53, at 2-3. It has been suggested that this view accounts at least in part for the "official sanctioning" of the principle and necessity of debt relief, as evidenced by the agreement reached by the group of seven industrial powers at the 1988 Toronto Economic Summit. There the creditor governments undertook to cancel, reduce, or restructure one-third of the debt owed to them by the poorest countries. See generally *WORLD DEVELOPMENT REPORT 1990*, *supra* note 24, at 126; Westlake II, *supra* note 46, at 13. The governments of Canada, Germany, the United Kingdom, and the United States have forgiven \$5 billion in public loans to sub-Saharan African countries. See Postel & Flavin, *supra* note 24, at 170, 176.

stance. Because there is no conventional legal mechanism for ensuring that debt is paid back, a firm international practice of payment is perhaps the only guarantee that can be given to otherwise reluctant creditors. Whether loan forgiveness is justified in the particular context of developing nations in the 1990s is a question that cannot be resolved here. We will assume that any large-scale program of forgiveness is unlikely, while noting that the case for loan forgiveness might have implications for debt-for-nature and technology-for-nature trades.

The picture that emerges, then, is one in which developing countries are under severe economic pressure, in significant part because of foreign debt, and in which environmental degradation is a predictable if myopic strategy for the accumulation of necessary funds. Part III explores strategies that deal simultaneously with the existence of foreign debt and environmental harms.

III. TRADING DEBT FOR NATURE

A. *The Agreement*

1. History

The idea that debt might be exchanged for nature was originally proposed in 1984 by Dr. Thomas E. Lovejoy, then Vice-President for Science at the World Wildlife Fund ("WWF"). Lovejoy noted that programs calling for the management of natural resources were often eliminated by countries that needed to reduce spending. Such countries thereafter relied on foreign donors to obtain the funds necessary to support national parks. According to Lovejoy, it would be a simple and direct solution for developed countries to take advantage of the debt crisis to deal with environmental problems that threatened developing and industrialized nations alike. The solution was to create transactions by which public or private actors in developed countries would agree to retire some of the debt of a developing nation in return for an agreement to protect natural resources.⁶⁷

The idea was implemented for the first time in 1987. Lender banks, especially frustrated that debts had appeared to become

67. See Thomas E. Lovejoy III, *Aid Debtor Nations' Ecology*, N.Y. TIMES, Oct. 4, 1984, at A31; Kathryn S. Fuller & Douglas F. Williamson, *Debt-for-Nature Swaps: A New Means of Funding Conservation in Developing Nations*, 11 Int'l Env'tl. Rep. (BNA) 301 (May 11, 1988).

uncollectible, sought new means for alleviating this liability.⁶⁸ A number of conservation organizations offered to acquire foreign debt from the banks and then retire the debt in return for conservation. The first swap occurred in July 1987, as Conservation International ("CI"), a private organization, purchased \$650,000 of Bolivia's commercial debt through Citicorp Investment Bank for \$100,000. In exchange the President of Bolivia agreed to set aside over four million acres of tropical forest for national protection and to create a \$250,000 fund for managing the area.⁶⁹

Many debt-for-nature trades have followed. In December 1987, Ecuador and the United States branch of WWF ("WWF-US") completed an exchange involving the purchase of \$1 million of Ecuadoran debt at thirty-five cents on the dollar; this exchange was the first of a \$10 million debt-for-nature program approved by the government of Ecuador. The second exchange under the Ecuadoran program, involving the remaining \$9 million, took place in April 1989. The Nature Conservancy ("TNC") and the Missouri Botanical Gardens joined WWF-US as purchasers of the debt at twelve cents on the dollar.⁷⁰

Costa Rica participated in its first of five exchanges in February 1988. A recent swap, in March 1990, brought the total face value of Costa Rican debt exchanged to \$79,253,631. The purchasers of the debt involved in the various Costa Rican exchanges included WWF-US, TNC, Holland, Sweden, and the National Parks Foundation of Costa Rica, with WWF assistance.⁷¹

WWF-US has completed two swaps in the Philippines, the most recent of which occurred in August 1990, exchanging an aggregate of \$1,290,000, at rates of 51 and 48.75 cents on the dollar

68. For a discussion of the range of items on banks' "menus" of available financing options, see generally Chamberlin et al., *supra* note 53.

69. See *Blueprint for Conservation and Development: Swapping Debt for Nature*, TROPICUS, Fall 1987 (available from Conservation International, Washington, D.C.). See also WORLD WILDLIFE FUND, THE BOLIVIAN CASE (undated and unpublished document, available from WWF, Washington, D.C.).

70. See WORLD WILDLIFE FUND, THE ECUADORAN CASE (undated and unpublished document, available from WWF, Washington, D.C.); WORLD WILDLIFE FUND, OFFICIALLY SANCTIONED AND FUNDED DEBT-FOR-NATURE SWAPS TO DATE: DECEMBER 1990 (unpublished table, available from WWF, Washington, D.C.) [hereinafter WWF SWAPS TO DATE].

71. See WORLD WILDLIFE FUND, THE COSTA RICAN CASE (undated and unpublished document, available from WWF, Washington, D.C.); WWF SWAPS TO DATE, *supra* note 70.

respectively.⁷² WWF-US' two exchanges in Madagascar involved a total of \$3,030,475; in Zambia, WWF-International purchased debt with a face value of \$2,270,000; and in Poland, WWF-US purchased \$50,000 of debt.⁷³ TNC and the Puerto Rican Conservation Trust, in March 1990, bought debt of the Dominican Republic having a face value of \$582,000.⁷⁴

2. Mechanics

The mechanics of debt-for-nature swaps follow a basic pattern.⁷⁵ An interested group, usually an international nongovernmental organization ("NGO"), purchases, on the secondary market, developing country debt held by an international lender. The price is discounted from the face value of the debt.⁷⁶ The purchasing group then trades its right to repayment of the debt for a commitment on the part of the developing nation to protect, in some fashion, the environmentally vulnerable lands within its territory. This trade may involve exchanging the debt instrument directly for legislative protection by the debtor country government. Alternatively, it may involve transferring the debt to a debtor country conservation organization, which will then turn it over to its government in exchange for local currency or local currency bonds to be used to finance a conservation program managed by the local group.

The parties to debt-for-nature agreements have fashioned a number of variations on this basic model. These variations often increase the complexity of the deal, but they also increase the likelihood of serving the interests of everyone involved. In the Bolivia swap, CI traded the debt that it had purchased on the secondary market with the government of Bolivia in direct exchange

72. WWF SWAPS TO DATE, *supra* note 70; WORLD WILDLIFE FUND, PHILIPPINES DEBT-FOR-NATURE SWAP TERM SHEET (undated and unpublished document, available from WWF, Washington, D.C.).

73. WWF SWAPS TO DATE, *supra* note 70.

74. *Id.*

75. For an elaboration on the mechanics of debt-for-nature swaps and a description of the process of negotiating such transactions, see Konrad von Moltke, Debt for Nature: An Overview 1-2 (undated and unpublished paper, available from WWF, Washington, D.C.).

76. To date, debt-for-nature trades have involved the purchase of commercial bank debt, for which a secondary market exists; discussions are underway, however, to enlist the resources of some types of bilateral government debt for these swaps. See DEBT-FOR-NATURE: SOME COMMON QUESTIONS 2-3 (Sept. 1990) (unpublished paper, available from WWF, Washington, D.C.).

for legislative measures.⁷⁷ In successive swaps, the nature portion of the transactions has most often been structured to include support for local conservation groups — a crucial step. In the first exchange of the Ecuadoran program, WWF-US acquired debt with a face value of \$1 million at thirty-five cents on the dollar and assigned this debt to Fundación Natura. Fundación Natura exchanged this debt for government bonds issued in sucres at 100% of the debt's face value. Both the interest and the principal of the nine-year bonds are to be used to finance Fundación Natura conservation activities.⁷⁸

The mechanics of the Philippines swap were similar to those in the Ecuadoran swap, except that the exchange was for cash rather than local currency bonds. The Philippines' Central Bank credited the full value of the debt to a local currency account for the benefit of the Haribon Foundation, a conservation group in the Philippines, and the Department of Environment and Natural Resources.⁷⁹

3. Environmental Commitments

The environmental commitments undertaken in the various swaps accommodate a broad array of ecological and policy goals of the various developing countries. These commitments range from the preservation of specific areas, to the creation of programs for education and training, to the establishment of funds for environmental uses whose details are left to later determination. In the Bolivian arrangement, for example, the government elevated to the highest legal protective status the existing 334,200-acre Beni Biosphere Reserve. It also created, with the same level of legal protection, an adjoining 877,205-acre reserve, as well as an additional 2,870,561-acre buffer zone — the Chimane Forest Reserve — to be developed in a sustainable man-

77. See THE BOLIVIAN CASE, *supra* note 69.

78. See WORLD WILDLIFE FUND, ECUADOR DEBT-FOR-NATURE SWAP TERM SHEET (undated and unpublished document, available from WWF, Washington, D.C.); THE ECUADORAN CASE, *supra* note 70. The first exchange of the Costa Rican program was similarly structured, although the bonds issued in colones represented only 75% of the face value of the indebtedness for which they were exchanged. WORLD WILDLIFE FUND, COSTA RICA DEBT-FOR-NATURE SWAP TERM SHEET (undated and unpublished document, available from WWF, Washington, D.C.); THE COSTA RICAN CASE, *supra* note 71. For criticism of this aspect of the Costa Rican arrangement, see Chamberlin et al., *supra* note 53, at 445 n.115.

79. See PHILIPPINES DEBT-FOR-NATURE SWAP TERM SHEET, *supra* note 72; WORLD WILDLIFE FUND, THE PHILIPPINES CASE (undated and unpublished document, available from WWF, Washington, D.C.).

ner. Finally, Bolivia designated the local currency equivalent of \$250,000 for the establishment of an operational fund for the management of the Biosphere Reserve.⁸⁰

Under the Ecuadoran agreement, the interest paid on the bonds during the first year is to be used for the protection and management of several specified parks and reserves.⁸¹ The agreement provides that the interest paid on the bonds in successive years is to be used for projects later selected by Fundación Natura, in conjunction with WWF-US. Upon maturity of the bonds, the principal is designated for the establishment of an endowment fund to support the general activities of Fundación Natura.⁸²

The Philippines swap, in addition to funding the protection and management of two specified reserves, emphasizes the need for education and training. The agreement envisages a range of programs, from field training to university fellowships. The terms of the agreement prohibit the use of any of the proceeds for the compensation of non-Philippine consultants.⁸³

The Madagascar commitments include funding the training and equipment of 400 park rangers for certain protected areas.⁸⁴ Finally, the Zambia agreement, among other things, provides specifically for the alleviation of habitat degradation and the protection of that country's threatened rhinoceros and elephant populations.⁸⁵

80. See Chamberlin et al., *supra* note 53, at 441-42; THE BOLIVIAN CASE, *supra* note 69; *Debt Trade Follow Up in the Beni Reserve*, TROPICUS, Winter 1988 (available from Conservation International, Washington, D.C.).

81. "Protection and management" includes the elaboration of management plans, the building of a management infrastructure, the institution of preservation and environmental education programs, and the sustainable use of natural resources. The designated areas are the Cayambe-Coca Ecological Reserve, the Cotacachi-Cayapas Ecological Reserve, the Sangay National Park, the Podocarpus National Park, the Cuyabeno Wildlife Reserve, the Yasuni National Park, the Galapagos National Park, and the Paschoa Nature Reserve. Attachment to Debt-for-Nature Agreement of December 14, 1987, between WWF-U.S. and Fundación Natura (unpublished document, available from WWF, Washington, D.C.).

82. See ECUADOR DEBT-FOR-NATURE SWAP TERM SHEET, *supra* note 78; THE ECUADORAN CASE, *supra* note 70.

83. See THE PHILIPPINES CASE, *supra* note 79.

84. See Kathryn S. Fuller, *Debt-for-Nature Swaps*, 23 ENVTL. SCI. & TECH. 1450, 1451 (1989).

85. See WORLD WILDLIFE FUND, ZAMBIA DEBT-FOR-NATURE SWAP TERM SHEET (undated and unpublished document, available from WWF, Washington, D.C.).

B. *Objections*

There have been a number of objections to debt-for-nature trades. The objections generally fall into four categories: (a) notions of political and economic sovereignty, (b) allegations of colonialism, (c) administrative and enforcement difficulties, and (d) limited results. We address each of these objections in turn.

1. *Sovereignty*

Some observers argue that debt-for-nature exchanges pose a threat to national sovereignty. This objection has taken various forms. Former President Sarney of Brazil has claimed that these exchanges are part of a campaign to halt development in poor nations.⁸⁶ Labor leaders in Bolivia have criticized what they see as, in effect, a sale of national assets to large international interests.⁸⁷ They contend that "if land today can be sold for environmental protection, tomorrow it can be sold under another cover but with the same end: accepting the dictates of the centers of political and economic power."⁸⁸ On this view, the debt-for-nature swap represents an effort by the economic powers of the developed north to exert political authority over the developing south.

At least in general, we believe that this objection has little merit. If developing countries have voluntarily entered into agreements to trade debt for nature, the fact that such agreements entail an intrusion on what would otherwise be rights of sovereignty is no objection. By hypothesis, both parties to a voluntary agreement are made better off. Indeed, the existence of foreign debt may well be a far greater threat to sovereignty than is an agreement to protect natural assets. Debt itself entails ownership of national assets by others. If this is so, sovereignty is enhanced rather than diminished by debt-for-nature trades. In any case, that issue appears at first glance to be one for the developing nation to decide; if the decision is voluntary, the objection from sovereignty seems weak.

More refined versions of the objection, however, are somewhat more plausible. Under the immediate pressure of the debt crisis,

86. Hobart Rowen, *Heading Off an Amazon Disaster*, WASH. POST, Apr. 2, 1989, at H1.

87. Erick Foronda, *Bolivia's 'Debt-for-Nature' Swap Comes Under Fire*, LATINAMERICA PRESS, Oct. 20, 1989, at 7.

88. *Id.* (quoting labor leader Andrés Soliz Rada).

developing nations may be tempted to enter into contracts that are not in their best long-term interest because they create a permanent loss of control over natural resources. Here the problem is that the relevant deal reflects a form of myopia — a rationale often brought forth to bar seemingly voluntary agreements.⁸⁹

Alternatively, it may be suggested that certain attributes of sovereignty should not be commodified, that is, that states ought not to be authorized to trade aspects of self-government in return for money. It might well be troubling, for example, if a country facing an enormous debt decided to trade, in exchange for dollars, the power to make a set of future decisions about its social and economic development, its religious and ethical commitments, its basic culture, or its forms of governance. This example presents two problems. The first involves one set of people binding future citizens who are not actual parties to the deal. The second involves the decision to allow a portion of self-governance — here the power to manage natural resources — to be traded on markets at all.

In the context of the ordinary debt-for-nature trade, we believe that these problems do not amount to powerful objections. With respect to the questions of myopia and implications for future generations, the central point is that the decision to protect natural resources is, to a significant degree, in the long-term interests of the developing nation, and is subjectively perceived as such. As we have seen, the exploitation of resources is often a product of the external pressure of the debt crisis rather than some internal free choice. The trade helps to relieve that pressure. Moreover, and crucially, future generations are made better rather than worse off through arrangements that relieve their own financial pressures, which would otherwise produce environmental degradation posing a severe threat to future citizens.

We also believe that the debt-for-nature trade poses no real threat of commodifying a nation's power of self-governance.⁹⁰ Any intrusion of that sort is minor in scale and scope. The presence of debt itself creates precisely the same threat, and to the extent that the trade reduces foreign debt, it actually frees up the nation's capacity for self-governance. Moreover, the trade en-

89. See, e.g., Cass R. Sunstein, *Legal Interference With Private Preferences*, 53 U. CHI. L. REV. 1129, 1164-66 (1986) (discussing myopia).

90. Cf. Margaret Jane Radin, *Market Inalienability*, 100 Harv. L. Rev. 1849 (1987) (discussing the risks of commodifying in general).

ables the nation to overcome a form of myopia, again produced by external pressures, rather than submitting to it. Frequently, economic development that is insufficiently respectful of environmental needs is a straightforward sacrifice of the future, and of future generations, for the immediate present. Insofar as debt-for-nature trades counteract this tendency, they are in the interest of everyone involved.

As we discuss below, the relevant concerns about sovereignty can be met through creative structuring of the trade.⁹¹ Such structuring attempts to ensure local participation and autonomy, thus strengthening local institutions and local options.

2.. Colonialism

It is sometimes suggested that the debt-for-nature trade involves a form of colonialism, that is, the imposition by wealthy countries of values held by them, an imposition made possible only by disparities in wealth. This argument seems largely to recapitulate arguments from sovereignty, and to do so in especially dramatic form.

We do not believe that this objection is persuasive. So long as the debts have been lawfully incurred, the foreign country has voluntarily entered into the deal, the agreement is structured to promote the ability of the developing nation to choose its own means of providing protection, and the goal is to prevent environmental degradation, the objection of colonialism seems misplaced.

To say this is not to deny that the objection points to significant risks. In light of those risks, it is important to ensure that the arrangement is organized so as to promote flexibility and to maximize the capacity of the developing country to protect its own resources in its own way. Agreements by which developed countries impose a highly particular environmental philosophy, select means of carrying out environmental ends, or conscript managerial authority that might otherwise be respectful of native norms and traditions, might well provide a basis for legitimate complaint. We return to these issues below.⁹²

91. See *infra* part III(C).

92. See *infra* part III(C).

3. Administrative and Enforcement Difficulties

Sometimes it is said that the debt-for-nature trade poses insuperable problems of administration and enforcement. Suppose, for example, that a question is raised about whether the developing country has complied with some provisions of the deal. How are such questions to be resolved? No international tribunal is in a position to ensure compliance with the agreement or to provide remedies in the event of a default.

Without an enforcement mechanism, the parties must depend on the monitoring capacity of one side or on the good faith of the other. Perhaps these will be sufficient, independently or in conjunction, in most cases. Without more particular information, however, it is difficult to know whether optimism is justified. For this reason, concerns about administrability are warranted.⁹³

4. Limited Results

It is also suggested that debt-for-nature trades will, at best, produce limited results. Although recent exchanges and programs have involved increasingly ambitious amounts of debt, numerous financial and regulatory constraints remain. First, commercial banks have only limited incentives to sell or donate the debt for use in such exchanges. Such banks would, of course, prefer to receive full repayment of the debts. In light of ongoing debt negotiations, they will usually be reluctant to compromise their bargaining position by offering a discounted rate in a debt-for-nature exchange.

Despite these limitations, banks will realize some benefits from the donation or sale of the debt at a greatly reduced price. In the case of a sale, banks can remove from their books a nonperforming loan and receive a bad debt tax deduction for the remainder; in the case of a donation, they will gain goodwill from favorable

93. According to the March 1990 report of the compliance review of the 1988 Costa Rican swap, the parties charged with managing the trust and its yield have performed well and Parque Nacional Guanacaste ("PNG") has been undertaking in good faith to purchase a parcel of land identified for protection under the swap arrangement. See WORLD WILDLIFE FUND, COMPLIANCE REVIEW OF 1988 COSTA RICAN DEBT-FOR-NATURE AGREEMENT 5 (March 1990) (unpublished report, available from WWF, Washington, D.C.) [hereinafter COSTA RICAN COMPLIANCE REPORT]. The problem remains, however, that it is simply too early to assess the level of compliance, and conclusions drawn in audits of the sort undertaken by WWF in Costa Rica are preliminary at best.

publicity and receive generous tax treatment.⁹⁴ In general, however, these benefits simply do not warrant — especially in the eyes of the shareholders — large-scale use by the banks of this strategy for reducing their outstanding debt.⁹⁵ The limited incentives for participation by banks significantly reduce the effectiveness of the debt-for-nature scheme in eliminating third world debt.

Other potential sources of financing can, at present, provide only relatively small amounts. International NGOs cannot devote financial resources on the scale required, and international aid agencies have been, for the most part, unable or unwilling to offer significant funding.⁹⁶ Moreover, regulations imposed by debtor nations, and restrictions imposed by previous debt restructuring agreements, may limit the amount of debt eligible for debt-for-nature exchanges.⁹⁷

94. For a detailed analysis of the relevant United States tax incentives after recent changes, see Terrill A. Hyde, U.S. Taxes: The Issues (undated and unpublished paper, available from WWF, Washington, D.C.).

95. Nonetheless, insofar as banks have decided to trade their debt on the secondary market, conservation groups are welcomed as would be any other purchaser. Many additional factors explain individual banks' interests in debt-for-nature exchanges, including their portfolio composition and their desire to maintain long-term financial relations with particular countries. For discussion of commercial banks' perspective on debt exchanges, on which we have drawn here, see von Moltke, *supra* note 75, at 3-4; Chamberlin et al., *supra* note 53.

96. The participation of the United States' Agency for International Development ("AID") in the Madagascar swap provides a welcome exception to the general reluctance of governmental aid agencies. AID granted \$1 million to WWF to facilitate the 1989 Madagascar exchange. See *A Debt to Nature*, THE ECONOMIST, Aug. 19, 1989, at 31.

Although the multilateral development banks ("MDBs") have yet to commit funds to a debt-for-nature swap, there have been several indications of support, from, among others, the United States Department of Treasury and the MDBs themselves, for involving MDBs in the financing of these arrangements. Congress enacted, in December 1989, The International Development and Finance Act of 1989, encouraging, among other things, MDB involvement in debt-for-nature swaps. See International Debt Exchanges and the Environment, Title V, Subtitle B of the International Development and Finance Act of 1989, Pub. L. No. 101-240, §§ 511-12, 103 Stat. 2492, 2507-10 (codified at 22 U.S.C. §§ 262p-4i-4k, 262p-5 (Supp. I 1989)). The International Bank for Reconstruction and Development supports the debt-for-nature swap strategy, but claims that its charter prevents it from financing or negotiating debt-for-nature swaps involving outstanding public debt, although it might be able to perform the function of a clearinghouse for information. See Chamberlin et al., *supra* note 53, at 440 n.99; WORLD BANK, THE WORLD BANK AND THE ENVIRONMENT: FIRST ANNUAL REPORT 78-79 (1990).

For criticism of World Bank's rhetoric without action, see Joannides, *supra* note 11, at 175 & n.75.

97. Not all public sector debt of a developing country may be eligible for exchange. Some restrictions are carried on the debt instruments themselves; others are informal, imposed for policy reasons by the developing countries. See Chamberlin et al., *supra* note 53, at 435 & nn.81-82. See also von Moltke, *supra* note 75, at 1-2.

Finally, large-scale debt exchanges have a serious potential inflationary impact on the economy of the developing country.⁹⁸ This consideration necessarily imposes limitations on the magnitude of debt-for-nature programs. Participants in recent swaps, sensitive to this potential problem, have included mechanisms that mitigate inflationary effects, such as converting debt into local bonds rather than cash.⁹⁹ Yet they concede that addressing this criticism will at some point require the imposition of ceilings on the amount of debt converted.¹⁰⁰ It appears that the extent of environmental protection to be generated by such trades will be far less than is necessary to protect the long-term environmental interests of either the developing nation or the world.

This point is crucial. Even if debt-for-nature exchanges were to continue to grow in number and scope, they would have only limited impact. The debt of developing countries is so enormous that trades of this sort will make only small inroads.¹⁰¹ Even more important, developing countries cannot continue to meet the burdensome requirements of debt servicing and repayment by engaging in unsustainable productive practices. We have seen that the self-destructive nature of these practices threatens severe environmental harm.¹⁰²

A more basic problem is that the solution offered by debt-for-nature swaps is superficial. It does not provide a mechanism for changing the incentives for engaging in destructive behavior. Debt-for-nature trades do little to change the underlying pressures of debt and environmental destruction, and do not offer an alternative way for developing countries to manage these pressures. In failing to present a long-term solution, debt-for-nature trades can provide only a partial corrective.

98. See Chamberlin et al., *supra* note 53, at 446.

99. See Fuller, *supra* note 84, at 1451.

100. See Fuller & Williamson, *supra* note 67, at 302, 303; David Reed, Debt for Nature Controversies (Dec. 1989) (unpublished paper, available from WWF, Washington, D.C.).

101. It should be noted, however, that some proponents of debt-for-nature swaps maintain that these arrangements were never intended to have an appreciable impact on the debt crisis. See Reed, *supra* note 100. Instead, they argue, the purchase and exchange of discounted debt merely serves as a funding mechanism, permitting developed countries or international environmental groups to leverage their conservation dollars. See Fuller & Williamson, *supra* note 67, at 302.

102. See *supra* part II(A).

This point is not an objection to such trades. It is an invitation to develop alternative strategies for promoting sustainable development. We turn to such mechanisms in Part IV.

C. *Variations in Answer to Criticisms*

It is possible to structure debt-for-nature trades so as to minimize the grounds for objection. In each case, of course, the transaction must be designed to address the unique concerns of the individual debtor country. We believe, however, that there are many general lessons to be taken from the experiences of existing swaps.

Perhaps the most important is the need to take into account legitimate sovereignty concerns. Ideally, the debtor nation would initiate a debt-for-nature program and approach international NGOs to participate in exchanges under the program.¹⁰³ Whether or not there is such an impetus, however, it is critical that the debtor country government and local conservation groups be involved from the outset — contributing to the identification of priorities; to the conception of projects; and, throughout the projects, to the management of activities.¹⁰⁴

One strategy, favored by many participants in existing debt-for-nature programs, involves directing funds to established conservation programs in the debtor country. This tactic responds directly to criticisms that debt-for-nature trades provide a tool for the imposition of northern values or of a particular environmental ethic. It also undermines claims that local conservation groups are being co-opted to carry out the goals set by large international organizations. Moreover, because the debtor country government and, perhaps, local conservation groups have fashioned the conservation program without external influence from inter-

103. The fact that the concept underlying the Ecuador program originated with the then president of Fundación Natura, Ecuador's leading private conservation organization, is cited as contributing to the recognition of the Ecuador arrangement as one of the most successful debt-for-nature swaps. See Fuller, *supra* note 84, at 1451.

104. *Id.* See also Reed, *supra* note 100. For a summary of the criticisms of the initial attempts at debt-for-nature transactions, see Eve Burton, *Debt for Development: A New Opportunity for Nonprofits, Commercial Banks, and Developing States*, 31 HARV. INT'L L.J. 233, 241-43 (1990). We believe that, in concluding that all debt-for-nature swaps are inherently flawed on this count, Burton overstates the case for sovereignty. But we agree there are important lessons to be learned about the need to address sovereignty concerns. Cf. MARTHA ALTER CHEN, *A QUIET REVOLUTION: WOMEN IN TRANSITION IN RURAL BANGLADESH* 5-17 (1989) (discussing overcoming of women's illiteracy in Bangladesh through strategies that incorporate views and perspectives of Bangladeshi women).

national NGOs and others, there is an increased likelihood that the funds will be used to further the true goals and interests of the developing country, and will be perceived as doing so. Finally, this strategy helps strengthen environmental education and environmental constituencies in the developing country, in a way that should accomplish long-term good.¹⁰⁵

Concerns about administrability and implementation can also be alleviated in some measure by careful structuring of the debt-for-nature arrangement. Again, involvement by the debtor country conservation group is essential. Local groups are in the best position to ensure that programs are implemented. They have established liaisons with the community and local public officials, and these liaisons are often vital to carrying out the intended programs.¹⁰⁶ Debtor country conservation groups also have the greatest interest in long-term local environmental viability and thus in the success of the projects undertaken as a result of the swap. Finally, they are in the best position to see that local knowledge and experience are brought to bear on the implementation of the program, thereby enhancing its cultural compatibility and its efficacy.

Another means of addressing concerns about compliance involves selection of the right mechanism for disbursing funds in the developing country. Any such mechanism should enhance the financial stability — and thus the likelihood of continued success — of environmental protection efforts. One desirable method, employed in the Ecuador arrangement, is the use of bonds. These provide an initial steady flow of funds and create, upon maturity, an endowment fund upon which the local conservation group can rely for its future activities.¹⁰⁷

In addition, agreements should contain data collection and disclosure agreements. Annual reports might well outline progress

105. On the importance of internal initiative, see JEAN DRÉZE & AMARTYA SEN, *HUNGER AND PUBLIC ACTION* 159 (1990).

106. The constant involvement and local residency of the Parque Nacional Guanacaste ("PNG") in Costa Rica has been indispensable to ongoing negotiations for the purchase of the Santa Elena property, as contemplated by the swap agreement. See COSTA RICAN COMPLIANCE REPORT, *supra* note 93, at 5.

107. See Fuller & Williamson, *supra* note 67, at 302 ("Because the [Ecuadorian] bonds have a nine-year term, the planning and implementation of long-range programs can proceed without fear that project funding may be cut off next year."). For the view that large lump sum disbursements can be problematic, see von Moltke, *supra* note 75, at 5.

on the relevant commitments.¹⁰⁸ Finally, it is important to permit funds to be used for purposes of education and increasing environmental awareness among the population of the debtor nation. One of the primary goals for environmental policy is to increase the amount and availability of information about environmental issues, thereby promoting economic goals and, at the same time, serving democratic aspirations. Such initiatives also increase the likelihood that the environmental commitments made in debt-for-nature deals will survive future periods of economic difficulty. By promoting local understanding of environmental issues, education makes it more likely that there will be sufficient political will to ensure that the terms of the agreement are upheld, and that conservation and other environmental goals will be promoted in the future.

The overall success of debt-for-nature transactions can be increased by attention to an array of related issues. First, the potential inflationary impact of debt exchanges should be mitigated by the use of disbursement mechanisms that allow the debtor country to spread any repayments to the conservation group over a longer period of time.¹⁰⁹ Second, training programs in conservation and environmental sciences and management should be included in the conservation program of the developing countries. Such programs could range from complex technological matters, for local experts, to information applicable to daily life, including energy-efficient cooking techniques. This mechanism should facilitate the creation of the human and technical infrastructure necessary to strengthen the countries' long-term economic and natural resource base. Habitat protection should also be a central part of the agreement; this is a good way to provide long-term environmental protection.¹¹⁰

Finally, in some developing countries there is, in effect, a dual society of landed elites and poor. Debt-for-nature trades can be structured to encourage the participation of new, smaller conservation groups along with the established groups. These fledgling groups can thereby gain expertise and, importantly, provide alternative voices to challenge the existing system of vested economic

108. See French, *supra* note 8, at 164.

109. The use in the Ecuadoran swap of nine-year bonds, and the allowance of three to four years for payment of the cash owed under the Madagascar and Zambia swaps, help to accomplish this goal. See Fuller, *supra* note 84, at 1451.

110. See Ryan, *supra* note 16, at 23-26.

interests and priorities, many of which threaten the environment.¹¹¹ Participation of non-elite conservation groups from developing countries can enhance the likelihood that debt-for-nature programs reflect the needs of a wide cross section of the peoples of developing countries.

We conclude that through such strategies, it is possible to structure debt-for-nature trades in a way that responds to most of the traditional objections. So structured, such trades hold out considerable promise for decreasing debt and protecting resources in ways that benefit developing and developed countries alike.

Thus far, the record suggests that debt-for-nature swaps have produced good results in the real world.¹¹² Not even careful structuring of debt-for-nature transactions, however, can eliminate all of the relevant problems. One such defect, noted above, is that agreements that support debt-for-nature swaps are not readily enforceable, which is a serious concern.¹¹³ Second, we have suggested that potential parties, particularly those financing the debt side of the equation, are usually unable or unwilling to enter into these arrangements on a large scale.¹¹⁴ Finally, mechanisms that merely reduce debt obligations inadequately address

111. For a discussion of WWF's efforts to accommodate the interests of non-elite developing country conservation groups, see Reed, *supra* note 100.

112. When measured in terms of the amount of developing country conservation funds generated per dollar invested by international NGOs or other conservation purchasers, debt exchanges prove to be a successful means of leveraging conservation financing. For example, the first Ecuadoran exchange provided \$1,000,000 in conservation funds, at a cost to WWF of \$354,000; in the Zambia swap, WWF's \$454,000 generated \$2,270,000 for conservation; and in the 1990 Philippines exchange, WWF's \$438,750 bought \$900,000 in conservation funds. See WWF SWAPS TO DATE, *supra* note 70.

Other less quantifiable indicia of the success of debt-for-nature swaps include the continued, ambitious employment of this device by an increasingly diverse array of parties, including formerly skeptical developing country governments, governments of developed countries and their bilateral aid agencies, and multilateral development banks.

Whether there have been significant gains in environmental protection is more difficult to assess. In most cases, it is simply too early to discern whether debt-for-nature swaps have contributed measurably to either local or global environmental viability. Initial audits, however, have been positive. The WWF in March 1990 conducted a compliance review of the 1988 Costa Rican exchange and found that the funds from the swap had been "instrumental" in supporting important conservation program activities. See COSTA RICAN COMPLIANCE REPORT, *supra* note 93, at 9 (concluding that the results of the swap to date were positive).

113. See Timothy B. Hamlin, *Debt-for-Nature Swaps: A New Strategy for Protecting Environmental Interests in Developing Nations*, 16 *ECOLOGY L.Q.* 1065, 1085-87 (1989).

114. See *supra* text accompanying notes 94-97.

both the immediate issue of stemming deforestation and the more general problems of environmental degradation, because they do not change the incentives for engaging in that behavior. In Part IV, we propose the possibility of taking steps that deal more effectively with the problems of development and environmental degradation in developing nations.

IV. ENERGY EFFICIENCY, TECHNOLOGY, AND DEVELOPMENT

For developed and developing countries alike, there is a basic obstacle to environmental protection, energy independence, and economic growth: the absence of widespread implementation of techniques for energy efficiency. In the developing countries in particular, inefficient technologies are a severe local problem, one with potentially disastrous consequences for both particular countries and the world as a whole.¹¹⁵ Most fundamentally, more efficient energy output will allow for greater development at lower cost. For developing countries, the closely linked problems of poverty and development find a valuable if partial solution through energy efficiency.

Any strategy for using economic incentives to redress these problems would have to begin with an understanding of the potential economic and environmental advantages of energy efficiency. The short-term goal of such a strategy would be to ensure dissemination of efficient technologies. Ultimately, the effort would be to promote the widespread use of energy sources other than fossil fuels, which are the most important source of environmental degradation.¹¹⁶ We propose an arrangement — a technology-for-nature exchange — designed to facilitate these economic and environmental goals. We discuss the contours of such arrangements and suggest legal reforms to increase the effi-

115. As one example of the historical importance of technology to economic progress, consider that technological change is estimated to have accounted for 90% of the productivity gains in the United States economy between 1909 and 1949. See GOLDBERG ET AL., *supra* note 21, at 91. For a discussion of innovation in an integrated world economy and the suggestion that integration both increases the incentives for and the benefits from innovation, see PAUL R. KRUGMAN, *RETHINKING INTERNATIONAL TRADE* 166-67 (1990).

116. Eventually it will be necessary for countries now dependent on fossil fuels to find substitute energy sources, a conclusion shared by a wide variety of commentators. See, e.g., BARRY COMMONER, *MAKING PEACE WITH THE PLANET* 191-210 (1989); Christopher Flavin & Nicholas Lenssen, *Designing a Sustainable Energy System*, in *STATE OF THE WORLD 1991*, *supra* note 24, at 21, 38; John H. Gibbons et al., *Strategies for Energy Use*, in *MANAGING PLANET EARTH* 85 (1990); OPPENHEIMER & BOYLE, *supra* note 4, at 175-206.

cacy of the proposed exchanges. A particular problem is the lack of incentives to implement and distribute existing technologies to developing countries; we attempt to respond to that problem here.

A. *Energy Efficiency*

Energy, the capacity to do work, is indispensable to support productive activity. According to accepted wisdom, increased energy consumption is a prerequisite to economic growth.¹¹⁷ The view that consumption and development are inextricably linked underlies the use of energy consumption as a yardstick for economic progress.¹¹⁸ Energy efficiency technologies weaken the link between growth and increased consumption. It is for this reason that both scientists and policy makers have pointed to energy efficiency as the area holding the greatest potential for returns on private and public investments that will advance both environmental and developmental goals.¹¹⁹

1. Definitions

Energy efficiency is a relative term; it permits comparison of the amount of energy input required to produce a unit of output, that is, a given quantum of work, goods, services, or prosperity.

For purposes of assessing the overall efficiency with which a country uses energy, comparisons are often based upon energy intensities — measurements of the amount of energy required per increment of gross national product ("GNP") or gross domestic product ("GDP").¹²⁰ In the 1980s, for example, France required about half as much primary energy to generate a dollar of GDP as

117. GOLDBERG ET AL., *supra* note 21, at 219-20.

118. *Id.* at 2 ("So important is energy to human society that the magnitude of energy consumed per capita became one of the indicators of a country's 'modernization.'"). Consider, too, the history of the Soviet Union's energy policy, which traditionally involved subsidizing supply to republics and satellites and which encouraged consumption as a measure of wealth and prosperity.

119. *See id.* at 2-4, 63-65 (advocating a shift away from a supply-oriented approach to these problems to one that has its foundation in energy efficient end-use strategies). *See also* WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT, *supra* note 13, at 174.

120. *See, e.g.,* Gibbons et al., *supra* note 116, at 85-97. *Cf.* GOLDBERG ET AL., *supra* note 21, at 219-21 (cautioning against emphasis on GDP as indicator of economic growth in context of energy planning in developing countries because of tendency to skew policy). *See also* VANDANA SHIVA, *STAYING ALIVE: WOMEN, ECOLOGY AND DEVELOPMENT* 6-8 (1989) (criticizing use of measure of productivity, i.e. GNP, as measure of development and examining effect on ecosystem and women in developing countries).

did the United States.¹²¹ Europe's energy intensity, in total primary energy requirements per GDP, at 0.33 in the mid-1980s, shows it to be a far more efficient producer than Brazil, whose energy intensity was 0.58, and than Poland, whose energy intensity was 0.95.¹²²

One formulation of the concept, particularly useful for making comparisons among different technologies, measures how much primary energy is required by a given process or end-use to do work. Thus, for example, one can compare the light energy output, in lumens per unit of energy consumed in the lighting device, of kerosene lamps and electric (incandescent) light bulbs: the electric bulbs produce about 200 times the luminous output of kerosene lamps, that is, they are about 200 times as efficient.¹²³

2. Experience in the Developed World

The last two decades have seen dramatic and largely unanticipated increases in energy efficiency in the industrialized world. Energy demand projections, made in the 1970s by the United States Department of Energy and by the International Energy Agency, grossly overestimated primary energy supply requirements and have had to be revised as growth in energy demand has slowed throughout the 1980s.¹²⁴ The failure in demand projections resulted in large part from the unexpected emergence of a wide range of technologies using much less primary energy to provide various energy services.¹²⁵

In many industrialized countries, energy efficiency increased by an average of 1.7% annually between 1973 and 1983.¹²⁶ In the period 1978 to 1982, the final energy use per United States household decreased by 30%, representing a 7.6% per year average rate of decline.¹²⁷ According to one study, energy conservation strategies in various sectors increased energy efficiency by 2.5% annually between the mid-1970s and mid-1980s, with esti-

121. See GOLDEMBERG ET AL., *supra* note 21, at 73-74.

122. See INTERNATIONAL ENERGY AGENCY, ENERGY IN NON-OECD COUNTRIES: SELECTED TOPICS 1988, at 47, Table 30 (1988).

123. See GOLDEMBERG ET AL., *supra* note 21, at 258.

124. See *id.* at 78.

125. *Id.* at 85. A major factor contributing to this technological innovation was the six-fold increase in world oil prices following the oil crises of the 1970s. *Id.* See also BRITISH PETROLEUM COMPANY, *supra* note 38, at 12-13.

126. WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT, *supra* note 13, at 196.

127. GOLDEMBERG ET AL., *supra* note 21, at 169.

mated savings of over \$150 billion annually.¹²⁸ The result has been carbon dioxide, sulfur dioxide, and nitrogen dioxide emissions reductions of about 40%.¹²⁹

Moreover, there is great potential for continued energy efficiency gains. Much of the technology for such improvements already exists; some of it is commercially available. Compact fluorescent light bulbs, for example, which use 18 rather than 75 watts to produce the same amount of light and last over seven times as long as conventional bulbs, are currently available.¹³⁰ Compact fluorescent lamps and similar products could save over \$25 billion annually, and reduce hundreds of millions of tons of carbon dioxide emissions while providing other environmental gains.¹³¹

Although the average refrigerator now in use in the United States uses 3.4 kilowatt-hours of energy per liter per year, commercially available alternatives employing the best available technology use 1.3 to 1.7 kilowatt-hours per liter per year. Advanced prototypes would use 0.7 kilowatt-hours per liter per year.¹³² Improved windows in American buildings save about the equivalent of an Alaska pipeline — 1.8 million oil barrels each day — and new windows could provide large additional savings.¹³³ Two American utilities project 19% reductions over the next twenty years in carbon emissions from improved energy efficiency in buildings.¹³⁴

Steel production is another area where energy efficiency can produce significant results. In 1979, producers in the United States required 27 gigajoules (“GJ”) of final energy per ton of raw steel. Sweden’s average in 1976 was 22 GJ. The best available technology, now being adapted for commercial use in Sweden, would reduce the amount of energy required to 15 GJ. Technology now under development would bring this figure down to between 9 and 12 GJ.¹³⁵

128. See Claudine Schneider, *Energy Conservation*, EPA JOURNAL, Mar.-Apr. 1990, at 11, 12.

129. *Id.*

130. Lester R. Brown et al., *supra* note 20, at 180.

131. *Id.*

132. GOLDEMBERG ET AL., *supra* note 21, at 87, Table 2.1.

133. See Schneider, *supra* note 128, at 11-12.

134. Flavin, *supra* note 27, at 33.

135. GOLDEMBERG ET AL., *supra* note 21, at 87, Table 2.1.

3. Energy Efficiency and Global Warming

Carbon dioxide is the principal anthropogenic cause of global warming.¹³⁶ As noted above, the rate of increase in carbon dioxide emissions of the industrialized countries of Western Europe and North America decreased from about 3% per year in the period 1945 to 1972 to less than 1% per year in the period 1973 to 1984. Carbon dioxide emissions from developing countries, on the other hand, are increasing at a rate of 6% per year.¹³⁷

The rate of growth of global carbon emissions has also declined since 1973. Fully one-third of the drop, or about 1.1 billion tons of carbon, can be traced to the decreasing energy intensity of many national economies, that is, to increases in energy efficiency. The rising use of renewable and nuclear sources of energy played a smaller but still significant role in the decline. If the global expansion of emissions had continued at the pre-1973 rate, annual emissions today would be almost 3 billion tons higher.¹³⁸

While world carbon emissions increased from roughly 2.6 billion tons in 1960 to 5.6 billion tons in 1987, the efficiency with which carbon-containing sources of energy were used (measured here in carbon emissions per dollar GNP) increased markedly during the same period. Thus, whereas 411 grams of carbon per dollar GNP were released in 1960, this figure decreased to 327 grams per dollar in 1987.¹³⁹ The impact of improved energy efficiency would have been much greater, however, had the considerable gains in energy efficiency not largely bypassed the developing world. For example, the United States, the United Kingdom, West Germany, and France all realized a decrease in carbon emissions per dollar GNP averaging 173.5 grams from 1960 to 1987. During that same period, however, the carbon

136. The Intergovernmental Panel on Climate Change ("IPCC") estimates the expected contribution of carbon dioxide to the radiative forcing of climate change to be 61%. (The contributions of methane and nitrous oxide are, respectively, 17% and 4%.) These figures are derived by multiplying the 1990 emissions rate for each gas by its "Global Warming Potential," an index based upon such factors as the lifetime of the gas in the atmosphere, its molecular weight, the position and strength of the absorption bands of the gas, and the time period over which climate effects are of concern — in this calculation, 100 years. Thus, while carbon dioxide is "weak" relative to the other greenhouse gases if one measures radiative forcing on a molecule-per-molecule or kilogram-per-kilogram basis, these comparisons underestimate the influence of carbon dioxide on global warming. See IPCC REPORT, *supra* note 32, at 45-49, 61, Table 2.9. See generally *id.* chs. 1-2.

137. See *id.* at 10.

138. Flavin, *supra* note 27, at 18-19.

139. *Id.* at 19, Table 2-1.

emissions of India, Nigeria, Mexico, and Egypt increased on the average by 206 grams per dollar GNP.¹⁴⁰

Enormous disparities among nations persist. In 1987, Japan emitted only 156 grams of carbon per dollar GNP; the United States released 276 grams of carbon per dollar GNP; Poland emitted 492 grams of carbon per GNP; Mexico, 609; India, 655; and China, an astounding 2024 grams of carbon per dollar of GNP.¹⁴¹

Energy efficiency alone does not account for these disparities. The composition of primary energy sources relied upon by a country also plays a significant role in the measurement of carbon emissions per unit of GNP. Carbon emissions per unit of energy, even among the fossil fuels, varies greatly. Natural gas is the cleanest fossil fuel in terms of carbon emissions; oil contains about 44% more carbon per unit of energy than natural gas; coal, about 75% more.¹⁴² China's enormous carbon emissions level per GNP is thus due in part to its heavy dependency on coal, which accounted for 76% of China's primary energy consumption in 1989.¹⁴³ France, by contrast, emitted only 133 grams of carbon per dollar GNP in 1987, an amount lower than even highly efficient Japan.¹⁴⁴ This is explained in part by France's decision to encourage nuclear energy as a source of supply. Nuclear energy in 1989 contributed just under 30% to the total primary energy consumption in France.¹⁴⁵

Energy efficiency improvements, however, have the immediate potential to reduce fossil fuel consumption in industrialized nations by at least 3% annually.¹⁴⁶ Global implementation of energy efficiency measures from 1990 to 2010 could account for a 3 billion ton difference in the amount of carbon released into the

140. Calculations based on *id.* Note also that in Eastern Europe and the Soviet Union energy intensities remained essentially unchanged in the same period because both industries and consumers were insulated from the market incentives and pressures that induced energy efficiency gains elsewhere. Soviet per capita carbon emissions were almost two times the level of Western Europe, yet per capita economic output was only two-thirds that of Western Europe. *Id.* at 19-20.

141. *Id.* at 19, Table 2-1.

142. *Id.* at 22.

143. Calculation based on BRITISH PETROLEUM COMPANY, *supra* note 38, at 34.

144. Flavin, *supra* note 27, at 19, Table 2-1.

145. BRITISH PETROLEUM COMPANY, *supra* note 38, at 34.

146. Flavin, *supra* note 27, at 23.

atmosphere each year.¹⁴⁷ Such widespread application of energy efficient technologies will be more likely if governments help create economic incentives — by increasing the cost of using fossil fuels, decreasing the price of clean, renewable sources of energy, or both. Policies that accomplish this result through taxes or permitting systems are an especially good strategy.¹⁴⁸ They create appropriate incentives while leaving considerable flexibility to the marketplace. Several governments in European countries have proposed or enacted legislation providing for a tax on carbon dioxide emissions.¹⁴⁹

Because industrialized countries are the largest consumers of energy, the total amount of energy saved by the implementation of energy efficiency measures, and the commensurate reduction in carbon emissions, will be greater in industrialized countries than elsewhere. Developing nations, however, have much to gain from increased energy efficiency, since they are the least efficient consumers of energy and the least efficient users of carbon-intensive energy.¹⁵⁰ Developed and developing countries alike should welcome the decrease in carbon emissions produced by greater efficiency in developing countries. Importantly, as explained below, increasing energy efficiency in developing countries also destroys the link between energy consumption and development. For these reasons, increased energy efficiency should not be limited to the industrialized world.

147. *Id.* This estimate assumes a 3% annual rate of energy efficiency improvement, a rate that Flavin believes feasible with the implementation of currently available efficiency measures.

148. See Ackerman & Stewart, *supra* note 1, at 178-88 (discussing the benefits of permitting systems).

149. See Flavin, *supra* note 27, at 33. The Netherlands, for example, has instituted a system combining a general fuel charge, levied as an excise on petroleum fuels, natural gas, liquefied petroleum gas, coal, and coke, with a rebate program whereby industries receive a rebate or credit for undertaking approved pollution abatement activities. The revenues generated by this system finance the majority of the government's environmental programs. See NATURAL ENDOWMENTS, *supra* note 11, at 22 (citing OECD, ENVIRONMENT DIRECTORATE, THE APPLICATION OF ECONOMIC INSTRUMENTS FOR ENVIRONMENTAL PROTECTION IN OECD MEMBER COUNTRIES: DRAFT FINAL REPORT (June 1988)). The commission of the European Community has recently indicated that it plans to submit a formal proposal for a Community-wide energy tax. Half of the tax would be in the form of a general levy on energy generation and half would be based on the carbon content of a given fuel. *Commission Asked to Make Formal Proposal on Energy Tax to Address Climate Change*, 14 Int'l Env't. Rep. (BNA) 670 (Dec. 18, 1991).

150. See LEAN ET AL., *supra* note 17, at 118; INTERNATIONAL ENERGY AGENCY, *supra* note 122, at 47, Table 30.

4. Energy Efficiency and Developing Countries

Without energy efficiency technologies, developing nations would require increasingly greater levels of energy consumption in order to support their desire to industrialize, achieve a higher standard of living, and accommodate a growing population. The potential gains from energy efficiency in developing nations can be viewed as a sort of future energy source. The key virtue of energy efficiency is that it promotes economic growth in a way that simultaneously allows for environmental protection and energy conservation. At the same time, these technologies might ultimately increase independence, allowing developing nations to become more autonomous of the developed world.

Of course, wide variations exist among developing countries with respect to the composition of energy supply, the level and kind of energy services available, and the extent of any infrastructure and distribution network now in place. Some energy efficiency technologies developed for application in industrialized countries will be suitable for use in some developing countries with only minor adjustments. Other developing nations will require strategies and technologies vastly different from those now used in developed countries.

In impoverished areas of many developing countries, available technologies could be employed to harness a much greater percentage of current energy input, providing larger amounts of usable energy to meet basic needs. Currently favored cooking methods illustrate the present connection between poverty and inefficient energy use. Cooking in earthen pots over an open fire uses about eight times more energy than aluminum pots over a gas stove.¹⁵¹ The distribution of aluminum pots, pressure cookers, and fuel-efficient wood stoves would bring about significant gains in energy efficiency.¹⁵² Fuel-efficient wood stoves have been refined over traditionally employed models, using about half as much firewood per year.¹⁵³ The same \$2 billion required to finance the construction of a single nuclear power plant could instead fund the construction of 200 to 400 million energy-efficient stoves, at the current cost of \$5 to \$10 per stove — a number well

151. See WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT, *supra* note 13, at 196.

152. *Id.*

153. GOLDBERG ET AL., *supra* note 21, at 256.

in excess of that required to equip all of the urban and rural poor households in India.¹⁵⁴

In developing countries with more advanced economies and infrastructures, there are also large potential gains from energy efficiency. In Brazil, for example, the electricity sector provides numerous opportunities for efficiency improvements. Under the guidance of a national electricity conservation program (PROCEL) established by the government in 1985, many of these have been or are being implemented. A detailed study completed in 1984 helped provide impetus for the government undertaking. It indicated that for a total investment of \$10 billion in more efficient end-use technologies — such as refrigerators, street lighting, and motors — it would be feasible to defer construction of 22 gigawatts of new electrical supply capacity, which would have cost an estimated \$44 billion.¹⁵⁵

The energy savings to date have been substantial. By means of a concerted installation effort in Brazil, for example, PROCEL has led to the replacement of 280,000 incandescent street lights with mercury vapor and high pressure sodium lamps, resulting in savings of around 115 gigawatt-hours ("GWh") per year.¹⁵⁶ As of 1989, Brazil had realized overall savings of 1436 GWh per year from end-use technologies adopted.¹⁵⁷ Such measures have already been responsible for lowering electricity demand in that country by about 0.5 to 1.2% per year.¹⁵⁸

Ample opportunities have been identified for future improvements in Brazil. Audits of small and medium-sized industries and commercial buildings conducted from 1987 to 1989 revealed measures that could cut electricity use by an estimated 8 to

154. *Id.* at 364.

155. See Christopher Flavin, *Electrifying the Third World*, in STATE OF THE WORLD 1987, at 81, 88-89 (Lester R. Brown ed., Worldwatch Institute 1987).

156. Howard S. Geller & Jose R. Moreira, Brazil's National Electricity Conservation Program (PROCEL): Progress and Lessons 5 (Dec. 1990) (unpublished paper, available from American Council for an Energy-Efficient Economy, Washington, D.C.). In addition, the use of more efficient refrigerators contributed a total annual savings of 383 GWh as of 1989. Also as of 1989, the implementation of various other efficient lighting measures resulted in a combined electricity savings of 644 GWh/year. *Id.* at 19, Table 3.

157. *Id.* at 19, Table 3. Saving 1070 to 2500 GWh/year in Brazil is equivalent to the power typically supplied by 280 to 650 megawatts of hydroelectric capacity. Thus, with a marginal cost of about \$2000 per kilowatt, PROCEL has enabled utilities in Brazil to defer investing \$0.6 to 1.3 billion in new power plants, transmission lines, and distribution facilities. *Id.* at 7-8.

158. *Id.* at 14.

15%.¹⁵⁹ If refrigerator and freezer manufacturers were to begin producing only those models that achieved efficiency levels of the best technology available in 1993, new refrigerators and freezers would by 1998 consume approximately one-half as much electricity as the average of models produced in 1990.¹⁶⁰ The resulting national energy savings by the year 2000 would be about 5100 GWh per year.¹⁶¹

B. *Beyond Efficiency: Alternative Energy Sources*

For both developing and developed nations, the ultimate goal ranges beyond energy efficiency to new technologies having minimal adverse environmental consequences. Current efficiency technologies can be seen as a transition stage before widespread reliance on renewable energy sources and replacements for environmentally harmful substances.¹⁶² Many possibilities now exist for the use of renewable sources. Because of the complexity of these issues, we provide only a brief outline here.

The principal renewable sources of energy include wind, biomass, solar thermal, photovoltaic cells, and geothermal. These sources now supply about 20% of the world's energy, and it has been estimated that over half of U.S. energy use could be provided by renewables as early as 2030. Use of solar energy is especially promising, because solar rays are free, and because solar energy avoids the majority of highly polluting effects of fossil fuels and other sources of energy. Today, solar thermal panels are widely used to heat water in Cyprus, Israel, and Jordan, and a solar energy company in California is now providing electricity to homes at competitive prices.¹⁶³

Photovoltaic cells, which convert sunlight directly into electricity, have considerable potential. Technology should be available to put these cells into general use within the next few decades, and their cost is falling rapidly, from \$30 per kilowatt-hour in 1971 to about 30 cents today. They can be used to accomplish all of the tasks of fossil fuels. This technology is already in wide-

159. *Id.* at 3.

160. *Id.* at 6.

161. *Id.* at 6-7.

162. See OPPENHEIMER & BOYLE, *supra* note 4, at 175-206; COMMONER, *supra* note 116, at 191-243.

163. Flavin & Lenssen, *supra* note 116, at 26-28.

spread use in some rural areas in the Third World. In India, for example, more than 6000 villages now use them.¹⁶⁴

There has been dramatic progress with other renewables as well. Over the last decade wind power has fallen in price from 30 cents to 8 cents per kilowatt-hour, and wind-produced electricity is now receiving considerable use in California. Northern Africa and southern South America in particular could benefit from wind power, using it in the short-term for more than 20% of their energy. About a fifteenth of the world's electricity is now generated by hydropower, and there is considerable potential for growth here as well.¹⁶⁵ Biomass energy is used — through primitive technologies and with considerable environmental harm — to provide over three-quarters of the energy for several countries in Africa.¹⁶⁶ Though not strictly renewable, geothermal energy — based on the heat of the earth's core — is used in El Salvador, Nicaragua, and Kenya.¹⁶⁷

It is especially significant that developing nations frequently have abundant supplies of renewable energy resources. Indeed, one of the most attractive aspects of energy sources such as sun and wind is that they are more equitably distributed on a global basis than are the known fossil fuel reserves. These natural advantages remain insufficient, however, in the absence of proper incentives, investment capital, and appropriate technology. It is here that the international community might provide the necessary assistance to develop renewable sources of energy.

The picture that emerges, then, is one in which enormous opportunities exist for enlisting energy efficiency and other technologies to improve the outlook for local and global energy requirements, while simultaneously addressing environmental and developmental problems. As mentioned above, the principal advances in energy efficiency technologies have taken place in developed countries. If the potential gains from energy efficiency are to be realized on a global level, the solutions must not avoid

164. *Id.* at 28.

165. See BRITISH PETROLEUM COMPANY, *supra* note 38, at 34; GOLDBERG ET AL., *supra* note 21, at 378-80. There are, however, environmental barriers to reliance on hydropower, which impairs conservation efforts. See GOLDBERG ET AL., *supra* note 21, at 378-80.

166. Here it is especially important to provide better and more efficient methods, because biomass places a severe stress on agricultural resources. See GOLDBERG ET AL., *supra* note 21, at 226-31.

167. Flavin & Lenssen, *supra* note 116, at 30.

developing countries, especially in light of their grossly inefficient practices and the local and global costs of their environmental degradation. Ecological limitations and economic needs suggest that developing nations should implement existing energy efficiency technologies and encourage the development of means to use alternative renewable sources of energy.

The question is, therefore, how to develop arrangements which facilitate the worldwide use of energy technologies that limit or reduce environmental degradation.

C. *Technology-For-Nature Trades*

We suggest an altogether novel kind of exchange. Developed nations would transfer economically and environmentally sound technologies to developing countries. In turn, the latter would agree to protect natural resources. Specifically, the exchanges would involve the transfer of energy technology from an industrialized country in return for a commitment from a developing nation to stem deforestation and to protect biological diversity.

Trades of this kind would provide an exceptionally powerful tool for promoting development in poor countries, while at the same time contributing to the solution of local and global environmental problems. For developing nations, they offer not merely a minor reduction in debt, but an opportunity to ensure that economic growth proceeds in an environmentally responsible manner. They would enable developing countries to avoid becoming dependent on energy sources that have created so many environmental problems for the industrialized world. At the same time, they would save energy costs while permitting the energy use that is indispensable to development. In short, trades of technology for nature have greater long-term potential than debt-for-nature swaps to accomplish all the relevant goals.

More specifically, the proposed exchange would yield dramatic and long-term environmental and developmental benefits. It would seek to improve upon the benefits to be gained from the "debt" side of the debt-for-nature equation by transferring to the developing nation something that provides not immediate, short-term economic relief, but instead facilitates the recipient nation's long-term economic growth and political and economic independence. The transfer of energy technology in particular is designed to take advantage of the enormous current opportunities for increasing energy efficiency, while allowing growth to re-

main at least constant.¹⁶⁸ These arrangements would enable the recipient nation to become a more efficient consumer of energy, regardless of the source, and therefore to increase the prospects for economic development. These swaps could also facilitate the research, development, and application of renewable sources of energy particularly suited to the debtor country's needs. Importantly, such arrangements would contribute to the increase in technological capacity and research infrastructure in the developing nation.

This reduced dependence on non-renewable sources of energy would, in turn, increase the benefits on the nature side of the equation. Diminished demands on, for example, wood from the forests as a source of fuel would reduce deforestation, ideally to the point of sustainable use. Economic pressures, moreover, that overtax the natural resource base will be relieved in some measure, as less energy input will be required to produce a given level of economic output, thereby freeing capital to be redirected towards addressing the underlying causes of environmental degradation. Moreover, the continued development and use of energy-efficient technologies could reduce, on a worldwide basis, dependence on environmentally harmful fossil fuels. Some developing countries might eventually become exporters of efficient end-use technology or of surplus electricity generated from renewable primary energy sources.

We propose a trade of technology for nature, but it is important to point out that there are strong justifications for requiring industrialized nations to transfer technology to developing countries for free. Such measures might be required under some versions of theories positing a right to access by all nations to the universal heritage of technology.¹⁶⁹ They might also be justified on the view that industrialized nations have incurred such a duty because of their past and present irresponsible energy consump-

168. The idea here is that because developing nations use inefficient energy technologies, they have high energy intensities. The potential for a developing nation to reduce its energy intensity by employing energy efficient technologies already in existence is therefore great, and can be viewed as a sort of future energy resource possessed in a disproportionate amount by developing nations. See *supra* part IV(A).

169. This right is asserted, for example, in the *Declaration on the Establishment of a New International Economic Order*, G.A. Res. 3201, U.N. GAOR Special Ad Hoc Comm., 6th Special Sess., Agenda Item 7, at 3, U.N. Doc. A/9556 (1974), reprinted in 13 I.L.M. 715 (1974).

tion.¹⁷⁰ Measures to ensure that technological advances extend to developing countries might be required as a *quid pro quo* for demands that developing countries join international agreements to limit environmentally harmful practices.¹⁷¹ A grant of technology might also be based on the view that the global need for technologies is in large part a function of environmental hazards unleashed by productive forces from which industrialized nations have disproportionately benefitted.

The argument for such a grant might be straightforwardly redistributive in character, referring to the extraordinary wealth of some nations in comparison with others, the injustice of such large disparities,¹⁷² and the moral duty of those who are in an unjustly superior position to share their technological capacities with others who need them. Finally, this view might be founded on the idea that industrialized nations have a good deal to gain from the development of improved energy technologies throughout the world, namely, reduced aggregate pollution.

For present purposes, we take no position on these complex questions. A principal difficulty with making technology freely available is that it may diminish incentives to create the technol-

170. Statistics support this justification and underscore the inequity of current world disparities in energy use: per capita oil consumption in the United States for snowmobiles and recreational boats and vehicles, the equivalent of 1.6 GJ/year, is almost as much as per capita oil use in India for all purposes, which is 1.8 GJ/year. GOLDBERG ET AL., *supra* note 21, at 191. The average citizen of Bangladesh consumes less than 1.5% of the energy used by his or her United States counterpart. In especially striking terms, the energy content in the food eaten by an average North American is greater than the total energy used by a Bangladeshi for all purposes. *Id.*

171. This view finds support, for example, in Principle 12 of the Declaration of the REPORT OF THE UNITED NATIONS CONFERENCE ON THE HUMAN ENVIRONMENT at 4, U.N. Doc. A/CONF.48/14/Rev.1, U.N. Sales No. E.73.II.A.14 (1972) ("Resources should be made available to preserve and improve the environment, taking into account . . . any costs which may emanate from [developing countries] incorporating environmental safeguards into their development planning and the need for making available to them, upon their request, additional international technical and financial assistance for this purpose."). See also EXPERTS GROUP ON ENVIRONMENT LAW OF THE WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT, FINAL REPORT OF THE EXPERTS GROUP ON ENVIRONMENTAL LAW ON LEGAL PRINCIPLES FOR ENVIRONMENTAL PROTECTION AND SUSTAINABLE DEVELOPMENT (1986), reprinted in EXPERTS GROUP ON ENVIRONMENT LAW OF THE WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT, ENVIRONMENTAL PROTECTION AND SUSTAINABLE DEVELOPMENT: LEGAL PRINCIPLES AND RECOMMENDATIONS 35, 65-69 (1987) (Article 7 and accompanying comment). For a discussion of requests made by India and China for transfers of technology and capital assistance to offset the costs of adopting the alternatives to chlorofluorocarbons necessary to meet the terms of the Montreal Protocol on Substances That Deplete the Ozone Layer, see NATURAL ENDOWMENTS, *supra* note 11, at 22.

172. See generally THOMAS W. POGGE, REALIZING RAWLS (1990).

ogy in the first place. For this reason, one might expect governments in developed countries to provide compensation to industries with the relevant technology, and then to ensure that the technology is given to developing countries for free or for a below-market price. Such an approach introduces some of the complexities in a technology-for-nature trade.¹⁷³

1. Diffusion of Technology

There are many approaches for ensuring the dissemination of energy technology throughout the developed and developing world. Some argue that the diffusion of technology via market-driven mechanisms should not be hampered by government policies and private practices inconsistent with ordinary free markets.¹⁷⁴ Others counter that the necessary global transition to efficient and environmentally sound energy practices cannot be instituted without some combination of interventionist devices, such as technology transfer, subsidies, and loans to developing countries.¹⁷⁵ Because the benefits of energy efficiency are not fully internalized through markets, it seems clear that any sensible strategy must employ a mixture of market and non-market approaches. In any case, we believe that an exchange of technology for nature could play a significant role in any large-scale set of initiatives for disseminating energy technology.

The transfer of technology from developed to developing countries has historically elicited two principal objections. Both objections turn out to be versions of the same fundamental concern, namely, the possible insensitivity of transferors to the unique situation and needs of each developing country.

The first objection is that technology developed for use in an industrialized country may be ill-suited, and perhaps even harmful, for use in a particular developing nation. This criticism is based largely on experience in an era when most technology transfers occurred only in conjunction with the sale of equipment

173. In discussing those complexities, and proposing such trades, we do not mean to deny that a grant of technology might be desirable in some contexts. On the contrary, many of the considerations that we explore bear on such grants as well.

174. For a summary of market imperfections and distortions particular to the energy sector, and for a suggestion of reforms in national pricing policies, see GOLDBERG ET AL., *supra* note 21, at 325-28, 339-40.

175. See generally *id.* at 322-69.

by private enterprises from industrialized nations.¹⁷⁶ This sort of transfer is not representative of the broad array of technology transfers possible,¹⁷⁷ nor of the transfers that we envision. Nonetheless, the criticism provides an important warning: parties to a technology transfer must ensure the suitability of the technology for the recipient country.

This seemingly obvious requirement might easily be overlooked. The tendency to assume that technological advancement is tantamount to increased consumption, and that the needs of the developing countries replicate those of the developed world at an earlier stage in its industrialization, might lead to the creation of programs with perverse effects. The problem here is not only the opportunity costs of the misdirected resources but also the exacerbation of existing problems in the developing country. Thus, for example, a transfer that involves technology encouraging centralized energy supply systems might add to an already overcrowded urban population concentration. It may also contribute to the entrenching of the "dual society" of many developing countries, as the urban elite approach the consumption patterns of developed countries while the needs of the rural poor are not addressed.¹⁷⁸

Another example of inappropriate technology exacerbating existing problems involves transfers that are insensitive to the effect of the new technology in displacing economic activity. Transfer of certain technologies to countries with high unemployment can be destructive if they contribute to that problem and fail to capitalize on the abundance of labor.¹⁷⁹ This is a special concern in light of the fact that some advanced technology is especially

176. See David Dichter & Klaus Netter, *A New Look at Foreign Investment*, in UNITED NATIONS DEP'T OF PUBLIC INFO., DEVELOPMENT FORUM (Sept.-Oct. 1988) ("Early in the post-colonial period, the most significant technology transfers were made to developing countries by subsidiaries of [transnational corporations]. . . . No special considerations were made of Third World differences. . . . Important technical information was withheld from recipient countries.").

177. *Id.*

178. See GOLDEMBERG ET AL., *supra* note 21, at 219-21. In India, for example, about 88% of rural households depend entirely on kerosene for their lighting needs, and while the number of unelectrified villages is decreasing, the number of unelectrified homes is increasing. *Id.* at 258-60.

179. In the Indian state of Karnataka, in 1978 to 1979, 20 industries consumed nearly 69% of the state's electricity output and contributed less than 8% of industrial employment (18,270 people), whereas about 615 other industries consumed about 31% of electricity output and employed 217,027 people. *Id.* at 223-24 & Table 3.14.

adapted for large, energy-intensive, labor-saving industries rather than smaller, labor-intensive industries.¹⁸⁰

The second common objection to technology transfer is that some forms of transfer perpetuate the dependence of developing countries rather than encouraging their long-term self-reliance and genuine growth. In the area of energy technology, this criticism arose in response to past development aid projects, which were often conceived, constructed, and managed by policy makers, engineers, and consultants from the developed world.¹⁸¹ When these workers returned to their developed countries, any expertise and experience gained in the process was also effectively repatriated. The project left a new generating facility, for example, in the developing nation, but contributed little to its acquisition of human technical capacity or to the foundations of a research infrastructure.

This objection points to the same remedy as the first. Participation and involvement on the part of the developing country, including its researchers and NGOs, is crucial in all stages of the project, from conception to implementation. The substance and shape of the project should be a product of both nations, rather than dictated by one to another. Transfer arrangements that take the form of a joint research effort between developed and developing countries probably best accommodate this concern.

The response to both criticisms, then, is not that technology should never be transferred, but instead that transfer arrangements should be crafted so as to observe the imperative of local involvement in all cases. Transfers should, moreover, be fashioned with an eye toward achieving long-term technological self-reliance, and thus stability and growth, for developing nations.

2. Exchanging Technology for Nature

The concept of an exchange or trade of energy technology for nature encompasses a broad array of arrangements. Exchanges falling under this heading might occur, for example, in the context of intergovernmental agreements concerning environment and development. In this case one or both sides of the bargain — that is, the commitment to transfer technology or the commitment to promote environmental protection — might be under-

180. *See id.* at 223.

181. *See Joannides, supra* note 11, at 175-76.

taken in fulfillment of a party's obligations under the terms of an existing intergovernmental agreement.¹⁸²

Technology-for-nature exchanges might also be initiated by NGOs, wholly outside of any intergovernmental commitments. These would resemble the debt-for-nature arrangements currently in place. Finally, some versions of the proposed exchange might involve a hybrid. For example, a developing country might undertake specific measures under an international convention concerning the sustainable use of forests. These measures may be considered to fulfill its obligations under the nature side of the proposed exchange, while the technology side might be arranged outside of any governmental obligation to provide the technology.

In discussing the proposed exchange of technology for nature, we do not attempt to describe all of the possible arrangements and actors. Indeed, it would be a mistake to saddle the parties with a rigid formula. We seek instead to set forth the basic framework and to encourage the parties involved to fashion appropriately the contours of the arrangements.

a. The Parties: Roles and Interests

The roles and interests of some of the parties would be similar to those in current debt-for-nature swaps,¹⁸³ but some additional

182. There is great potential for the proposed exchanges to serve as a vehicle for translating the language of such international obligations into forceful commitments. This function is likely to be increasingly critical as international agreements contemplate comprehensive approaches to the concerns of environment and development, and as provisions for technology transfer and other forms of cooperation between developed and developing nations move from the realm of principle to that approaching legal obligation. Consider, in this regard, the provision for technology transfer in Article 5 of the amended Montreal Protocol, *supra* note 6, 26 I.L.M. at 1555-56, and the importance of this provision in securing the signature of such countries as India, see French, *supra* note 8, at 160-61; consider also the movement from the 1972 United Nations Conference on the Human Environment ("UNCHE"), *supra* note 171, to the 1992 United Nations Conference on Environment and Development, see *Preparatory Committee for the United Nations Conference on Environment and Development*, U.N. Doc. A/CONF.151/PC/61 (1991), and from the inclusion of Principle 12 in the Stockholm Declaration resulting from UNCHE, mentioning the need for "international . . . technical assistance," REPORT OF THE UNITED NATIONS CONFERENCE ON THE HUMAN ENVIRONMENT, *supra* note 171, at 4, to the anticipated inclusion in some of the international agreements resulting from the latter of specific provisions for technology transfer.

183. The basic parties to the proposed exchanges would likely include: a sponsoring international environmental group or other international broker (perhaps an international NGO with expertise in energy policy); a source of technology and possibly researchers from the developed country; an energy organization or project, including researchers, in

parties, and new roles for existing ones, would become necessary in at least some technology-for-nature exchanges.

As we envision it, the international broker — probably an international NGO or group of NGOs with experience in the areas of energy and environment — would often orchestrate the transaction. Regardless of the source of the project's initial impetus, the broker would perform the important function of identifying appropriate participants, particularly in the developing country. Ideally, the broker would itself be a cooperative effort between organizations from the developed and developing country. The interests of such a broker should be connected to the mutually advantageous results to be brought about by completion of the exchange.

Yet this alignment alone might not be sufficient to warrant the large investment of effort demanded of the broker by the complexity of the transaction. In addition to the interests common to all participants in the exchange, the international organization must see that there will be significant benefits over alternative uses of its resources. This criterion is likely to be met, however, because of the distinctive interplay of gains in the related areas of energy conservation, economic development, and environmental protection resulting from technology-for-nature trades. These gains are not as obvious or as readily quantifiable as the leveraging of conservation dollars, which provides the impetus for organizational participation in debt-for-nature transactions. But the return on a broker's investment is potentially far-reaching and great. In addition, governments may well enlist the services and expertise of such organizations in order to fulfill obligations for technology transfer or technological resource contribution under the terms of international agreements. NGOs may therefore be able in some cases to secure funding from governmental sources.

An NGO from the developing country, particularly one with an energy focus, might perform several critical functions. Regardless of whether it is active in the overall orchestration as the broker, it might play an important role as counterpart to the developed country NGO in conceptualizing the project and identifying appropriate participants from its country or region. As experience

the developing country; the government of the developing country; and a developing country conservation organization. The arrangement would also likely require participation by the developed country government or, perhaps, by bilateral or multilateral aid agencies.

in the debt-for-nature context has shown, much of the success of the exchange depends on local involvement at each stage in the process from inception to implementation.¹⁸⁴ The developing country NGO might itself be involved in energy research, or it might be concerned with energy and environmental issues. Both types of NGO would be capable of combining the necessary knowledge of local conditions and needs with the ability to solicit local researchers.

The developing country NGO might in some cases be made responsible for any training and educational activities created to ensure dissemination and implementation of the technology. Such a system would presumably serve the interests of the organization on several fronts. It would provide the means for the immediate realization of improvements in meeting energy requirements for development, strengthen local technological and research capacity, and create progress toward long-term economic health and environmental viability.

The developing country government would participate in a technology-for-nature exchange in much the same capacity as in the debt-for-nature context. Additional facets to this participation would likely be required as a result of government involvement in the energy sector.

The interests of the developing country in furthering economic development and environmental aims would be well served by such a transaction. Indeed, as discussed above, the potential for mutually reinforcing gains from a comprehensive approach is critical to the realization of either goal. The developing country government should welcome the opportunity to redirect the financial resources that otherwise would have been used to increase energy supply to meet growing demands. Indeed, such resources could be devoted to the conservation programs undertaken as part of the technology-for-nature transaction. In some cases, the developing country government may become better able to fulfill its obligations under international environmental agreements, thereby increasing the likelihood of observance by developed nations of the same agreements.

It is conceivable that such arrangements could occur without participation from the government of the developed country. The addition of that government to the cast would, however, be

184. See *supra* notes 103-11 and accompanying text.

highly beneficial, primarily in order to provide incentives to those conducting research in energy technology. Indeed, such exchanges might not be feasible without the involvement of these governments. The funding required may often exceed the resources of private organizations, and private industry has little incentive to participate independently in technology transfers at below-market prices. Developed country governments could provide tax incentives or subsidies, or establish an award program for researchers who develop technology for transfer or who otherwise cooperate with researchers in a developing nation. The developed country could also procure technology directly in order to influence the market in the direction of efficient and renewable energy technologies. Finally, the government might engage in research on its own, with the idea that the fruits of such research would not only be employed in the home country but also be available for transfer to developing nations.

Governments of industrialized countries might be interested in participating in such transactions as part of their development aid programs, on concessional terms, or for free. In any of these cases, the proposed technology-for-nature exchange offers greater opportunities than debt-for-nature agreements for return on their investment, for the same reasons that it offers this opportunity to the brokers of the transaction. In addition, obligations for technology transfer and scientific cooperation are likely to be included in an increasing number of intergovernmental agreements. The arrangement we propose would furnish a useful mechanism for meeting these obligations. The proposed exchange would also increase the likelihood that the provisions of such agreements will be — and can be — observed by developing countries.

b. The Commitments: Nature and Technology

It is difficult and perhaps unwise to attempt to specify the substance of the commitments of the proposed exchange in a vacuum, that is, removed geographically, culturally, and temporally from the particular context of the exchange. As is evident from the wide range of environmental commitments selected by the parties to the various debt-for-nature swaps,¹⁸⁵ the needs of the parties will vary greatly from country to country or from project

185. See *supra* part III(A).

to project. Indeed, it is this flexibility, and the potential for the parties to fashion appropriate variations, that constitutes one of the strengths of these arrangements as a tool for serving the interests of all involved.

Nevertheless, we offer a few suggestions of the sorts of commitments that might be suitable for technology-for-nature exchanges. In particular, we identify some of the energy technologies that might be the subject of such exchanges. In so doing, we draw upon a recent but growing body of work being done in this area, in both developed and developing countries.¹⁸⁶

In the process of describing the mechanics of debt-for-nature swaps, we have mentioned some of the commitments that might be undertaken on the nature side of the transaction.¹⁸⁷ The possibilities for this portion of the proposed technology-for-nature transaction would be similarly numerous and limited only by the requirements of the individual parties.

In the process of describing the potential for energy efficiency, we have also touched on some of the technologies that might be appropriate in some areas.¹⁸⁸ Efficient wood stoves, for example, could be widely employed in countries that rely on wood to meet basic cooking needs. Similarly, projects like those undertaken in Brazil might be appropriate in other countries where a similarly developed infrastructure exists,¹⁸⁹ where governments have be-

186. See, e.g., GOLDBERG ET AL., *supra* note 21 (United States, Sweden, India, Brazil); MICHAEL PHILIPS, INTERNATIONAL INSTITUTE FOR ENERGY CONSERVATION, ENERGY CONSERVATION ACTIVITIES IN AFRICA AND EASTERN EUROPE (Sept. 1990) (Ivory Coast, Senegal, Tunisia, Egypt, Hungary, Yugoslavia, and Turkey); MICHAEL PHILIPS, INTERNATIONAL INSTITUTE FOR ENERGY CONSERVATION, ENERGY CONSERVATION ACTIVITIES IN ASIA (Sept. 1990) (China, Philippines, Indonesia, Thailand, India, and Pakistan) [hereinafter CONSERVATION IN ASIA]; MICHAEL PHILIPS, INTERNATIONAL INSTITUTE FOR ENERGY CONSERVATION, ENERGY CONSERVATION ACTIVITIES IN LATIN AMERICA AND THE CARIBBEAN (June 1990) (Brazil, Argentina, Chile, Costa Rica, and Jamaica) [hereinafter CONSERVATION IN LATIN AMERICA AND THE CARIBBEAN]; Geller & Moreira, *supra* note 156 (noting the potential for energy conservation in Brazil). Many possibilities for energy efficiency have been identified in various studies and reports by the Energy Sector Management Assistance Program ("ESMAP"), many of which are discussed in MICHAEL PHILIPS, INTERNATIONAL INSTITUTE FOR ENERGY CONSERVATION, ALTERNATIVE ROLES FOR THE ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAM IN END-USE ENERGY EFFICIENCY (Oct. 1990) (Working Draft).

187. See *supra* part III(A).

188. See *supra* part IV(A)(4).

189. Projects successful in India are often emulated by other developing countries. TATA ENERGY RESEARCH INSTITUTE & INTERNATIONAL INSTITUTE FOR ENERGY CONSERVATION, PROPOSAL TO INITIATE PLANNING FOR A LOW CFC, HIGH EFFICIENCY REFRIGERATOR FOR MANUFACTURE IN INDIA 1 (Oct. 1990) (unpublished paper, available from the IIEC, Washington, D.C.). Dissemination of technology via this route, from one developing

gun to understand the benefits of pursuing demand-side or end-use planning over purely supply-side planning for their countries' increasing energy needs, and where various organizations are demonstrating an interest in cooperating in such programs.¹⁹⁰ Efficient end-use technologies for lighting, refrigeration, and transportation are but a few of the likely candidates for such exchanges.

The task for the parties to transfers involving these or similar technologies is to design and implement distribution networks, and to conduct necessary informational and educational activities in order to ensure dissemination of the relevant technology. Any modification necessary to tailor such technologies to the area in which they will be implemented could be undertaken primarily by local engineers familiar with the area's people and culture, working jointly with engineers from the developed country.

More challenging arrangements, with potentially greater long-term benefits, include the establishment of joint research efforts for the development of competitive applications of renewable sources of energy. One arrangement likely to prove fruitful in this decade would involve cooperative research and development of photovoltaic solar cell technology. This type of solar technology directly converts energy from the sun into electricity, bypassing mechanical conversion processes. As a result, it is well-suited for use in large electricity plants as well as small water pumps and rural communications systems.¹⁹¹ This technology is especially promising for the electrification of the widely dispersed villages of many developing countries, where systems requiring centralized plants and a matrix of extended power lines are less desirable.¹⁹² At present, photovoltaics are too expensive for widespread use, but scientists believe that advances will enable costs to be significantly reduced by the end of the decade.¹⁹³

country to another, is important and valuable for a number of reasons beyond simply ensuring the spread of technologies useful for environment and development goals. Indeed, the IIEC's "model country program" approach is designed to encourage developing countries to take advantage of this dynamic. See INTERNATIONAL INSTITUTE FOR ENERGY CONSERVATION, MODEL COUNTRY PROJECT TO IMPLEMENT ENERGY EFFICIENCY IN THAILAND 1 (undated and unpublished paper, available from IIEC, Washington, D.C.).

190. See *supra* part IV(A)(4); CONSERVATION IN ASIA, *supra* note 186; CONSERVATION IN LATIN AMERICA AND THE CARIBBEAN, *supra* note 186.

191. See Flavin & Lenssen, *supra* note 116, at 28.

192. See *id.* at 27 & Table 2-3; GOLDEMBERG ET AL., *supra* note 21, at 234.

193. Flavin & Lenssen, *supra* note 116, at 28.

Cooperative endeavors could draw upon ongoing efforts and resources in both developing and developed countries to further refine these technologies.¹⁹⁴ Such joint research initiatives should be structured so as to emphasize the facilitation of long-term local technological capability, with the ultimate aim of establishing or strengthening the developing country's infrastructure for research, development, production, and distribution.¹⁹⁵

From this description, it should be clear that, as in the debt-for-nature context, the proposed exchanges would involve a fairly complex constellation of actors. Technology-for-nature exchanges would, however, also share the best feature of their debt-for-nature predecessors: all of the potential actors stand to gain from the successful conclusion of the arrangement. Although the parties to technology-for-nature exchanges are numerous, the close interrelation of their goals should go a long way toward assuring the cooperation necessary to structure and execute such transactions.

D. *Legal Reforms*

To some extent, technology-for-nature exchanges could be undertaken without legal reforms. No statutory change is necessary

194. Cooperative efforts would also be fruitful with other renewable sources of energy supply, particularly in light of the mutual benefits attainable from collaboration with those developing countries geographically well-situated for research into technologies that harness a particular source of energy, such as wind energy. These countries may already have accumulated knowledge and valuable experience for the development of a particular technology. See GOLDBERG ET AL., *supra* note 21, at 384-89 (discussing experience in the development of wind power in various locations, including the State of Karnataka, in India).

195. A recent initiative taken by the IIEC in joint technology development of efficient, CFC-free refrigerators for manufacture in India, is illustrative of an approach involving collaboration between developed and developing countries with the ultimate goal of enhancing the developing country's independence. This example provides a model readily adaptable to cooperative efforts in the development of renewable energy technology. The IIEC is working on the project with the New Delhi-based Tata Energy Research Institute ("TERI"), which will involve participants from the refrigerator industry, research institutions, and governmental agencies from both the United States and India. The IIEC and TERI intend to perform oversight functions throughout the development phase of the project, but to end their involvement when the project becomes commercially viable. This exemplary project will thus increase Indian experience in research and development of this technology and result in the production and use in India of an efficient, environmentally sound refrigerator. See TATA ENERGY RESEARCH INSTITUTE, *supra* note 189, at 1-4.

to enable private parties to engage in such arrangements.¹⁹⁶ The requisite participation by national governments may be authorized by existing statutes.

There would be large advantages, however, in national and international legal and policy reforms designed to facilitate these exchanges. At a minimum, this would require the elimination, by the national governments of both developed and developing countries, of laws and policies that are inhospitable to the research and development of energy efficiency technology, and to the transfer of that technology.¹⁹⁷ Government intervention, at the least, must not disturb market incentives favoring conservation and innovation. Toward that objective, pricing policies for the energy sector must be recrafted so that prices accurately reflect the full costs of using energy — particularly that provided by fossil fuels — and take account of environmental and other externalities.¹⁹⁸

Reforms might also include measures that more actively pursue implementation of technology-for-nature exchanges. Recent initiatives at the domestic level are extremely promising. The Global Environmental Protection Assistance Act of 1989, for example, instructs the United States representative to the Development Assistance Committee of the Organization for Economic Cooperation and Development ("OECD") to initiate efforts by that body to coordinate approaches to global warming, tropical

196. As experience in the context of debt-for-nature exchanges has demonstrated, it is indeed nongovernmental organizations, rather than governmental entities, that are likely to pioneer endeavors involving such novel arrangements. See *supra* part III(A).

197. For developed countries, this could require the abandonment of policies that skew incentives for energy research and development, biasing them in favor of continued fossil fuel dependence. In the United States, for example, \$2.3 billion is slated for "clean coal" research during the next five years. See Flavin, *supra* note 27, at 27. Some developing countries might consider developing or strengthening a regime protecting intellectual property, in order to facilitate some types of transfer of technology and to encourage local innovation. See Richard T. Rapp & Richard P. Rozek, *Benefits and Costs of Intellectual Property Protection in Developing Countries*, 24 J. WORLD TRADE 75 (1990).

198. See generally PACE UNIVERSITY CENTER FOR ENVIRONMENTAL LEGAL STUDIES, ENVIRONMENTAL COSTS OF ELECTRICITY (1990). For recent suggestions for including environmental costs in accounting systems, see ERNST LUTZ & SALAH EL SERAFY, ENVIRONMENTAL AND RESOURCE ACCOUNTING: AN OVERVIEW (World Bank, Environment Department Working Paper No. 6, 1988); HENRY M. PESKIN, ACCOUNTING FOR NATURAL RESOURCE DEPLETION AND DEGRADATION IN DEVELOPING COUNTRIES (World Bank, Environment Department Working Paper No. 13, 1989); HENRY M. PESKIN & ERNST LUTZ, A SURVEY OF RESOURCE AND ENVIRONMENTAL ACCOUNTING IN INDUSTRIALIZED COUNTRIES (World Bank, Environment Department Working Paper No. 37, 1990).

deforestation, sustainable development, and biological diversity through bilateral aid programs.¹⁹⁹ Among the goals of these programs is the "improved exchange of information on energy efficiency and solar and renewable energy sources, and a greater emphasis on the use of those sources in development projects."²⁰⁰ To carry out this goal, the transfer of technology to developing countries seems indispensable.

Legislation that specifically envisages technology-for-nature exchanges, providing for both initiatives and the funding to carry them out, would be welcome. Legislation of this sort could replicate the provisions of section 711 of the Global Environmental Protection Assistance Act,²⁰¹ which gives such authority, in the context of debt-for-nature exchanges, to the Agency for International Development ("AID"). AID might similarly be empowered to initiate the transactions necessary for a technology-for-nature exchange, to purchase technology from industry and other sources, and to undertake negotiations with the various parties involved, including the developing country government.²⁰²

At the international level, there is a pressing need for coordinated measures to protect against environmental degradation while ensuring that such protection does not come at the expense of economic growth. To this end, we mention here three points. First, international legal instruments must, by their terms, recognize the interrelation between environmental protection and global economic health. Treaties and protocols are an important step, but to date they have been partial and ad hoc.²⁰³ We applaud the recent recognition — by provision for and preparations leading to the United Nations Conference on Environment and

199. The Global Environmental Protection Assistance Act of 1989 comprises Title VII of the International Development and Finance Act of 1989, Pub. L. No. 101-240, §§ 711, 721-22, 103 Stat. 2492, 2521-24 (codified at 22 U.S.C. §§ 2281-86 (Supp. I 1989)).

200. *Id.* § 722(6), 103 Stat. at 2523-24.

201. *Id.* § 711, 103 Stat. at 2521-23 (codified at 22 U.S.C. §§ 2281-86 (Supp. I 1989)).

202. AID was suggested as a promising candidate for orchestrating such exchanges by Howard S. Geller, the Executive Director of the American Council for an Energy Efficient Economy, in part because AID possesses some expertise gained from past participation in energy efficiency projects in developing countries. Telephone interview with Howard S. Geller (Jan. 24, 1991).

203. For discussion of the successes and failures of recent efforts to address concerns of environmental protection and sustainable development through international conventions, see Durwood Zaelke & James Cameron, *Global Warming and Climate Change: An Overview of the International Legal Process*, 5 AM. U. J. INT'L L. & POL'Y 249, 271-83 (1990); *Developments in the Law-International Environmental Law*, 104 HARV. L. REV. 1484, 1521-79 (1991).

Development²⁰⁴ — of the need to address developmental exigencies if progress in worldwide environmental protection is to be achieved. International agreements, however, must also facilitate the translation of this recognition into practice. In light of the complexity of the underlying causes of the problem, many of which lie outside of the traditional ambit of intergovernmental agreements addressing environmental concerns, accomplishment of this task will require agreements that encourage and establish a framework for innovative international cooperative efforts.

Second, it would be extremely valuable to position an international entity, perhaps operating through the United Nations, to facilitate cooperation among developing and developed countries toward the realization of sustainability.²⁰⁵ Such an entity might be charged with the missions of encouraging appropriate energy use in the pursuit of economic growth and environmental protection. It could also provide a much needed base for coordinating the various projects undertaken by the diverse groups already involved in efforts in the interrelated areas of energy, environment, and development.²⁰⁶ An important function of such an entity would be the establishment of standards for energy efficiency and technology transfer. The entity could operate as a clearinghouse for information on past and contemplated transactions, and could make recommendations for long-term solutions. Finally, such an entity should be structured and located in such a way as to assure maximum accessibility by developing countries. To this end, a system with connected regional branches seems preferable to a single centralized bureau.

Third, mechanisms should be created to ensure that any agreements, whether they involve debt relief or technology transfer, are enforceable. At the very least, the relevant exchanges should probably be subject to enforcement in the national courts of the developing country. This approach would weaken claims about

204. See G.A. Res. 228, U.N. GAOR, 44th Sess., Supp. No. 49, at 151, U.N. Doc. A/44/49 (1989).

205. It is not clear whether the necessary responsibilities ought to be located in an existing entity of the U.N. or an entirely new entity. Both options have advantages and disadvantages, and we do not take a position on their relative merits.

206. Under the auspices of the United Nations alone, a formidable number of programs, specialized agencies, and other entities share responsibility for economic development, appropriate energy use, and environmental protection. See CALIFORNIA INSTITUTE OF PUBLIC AFFAIRS, *WORLD DIRECTORY OF ENVIRONMENTAL ORGANIZATIONS* 33-45 (Thaddeus C. Trzyna ed., 3d ed. 1989).

intrusions on sovereignty. Alternatively, arbitration clauses in these agreements might allow enforcement of any arbitral award in any country that is a party to the United Nations Convention on Arbitration.²⁰⁷ Finally, the coordinating entity that we have proposed might be given monitoring and adjudicative functions. One or more of these approaches might be necessary to resolve problems that will likely increase in magnitude with the proliferation of environmental agreements.

V. CONCLUSION

In the next generation, development in poor countries presents a crucial challenge for environmental law and policy. Many such countries have little incentive to engage in environmental protection at all. All of them need assurance that the relevant programs are designed in a way that does not unduly compromise, and ideally promotes, the goals of development and political and economic independence.

Central to the realization of sustainable development will be the employment, on a worldwide basis, of strategies for efficient energy use. To achieve this goal, it will be necessary to create techniques to increase the efficiency of existing energy sources and ultimately to convert to new sources having fewer harmful environmental consequences. Both developing nations and their industrialized counterparts should promote the development and implementation of the necessary technology.

There is much to be said in favor of strategies that promote environmental protection and economic development by reducing the debt obligations currently burdening many developing nations. Suitably structured, debt-for-nature trades should accomplish considerable good. Standing alone, however, these strategies do far too little to address the need for efficient and alternative energy technology, which is the long-term prerequisite for the economic and ecological stability of developing nations. To be sure, there is a pressing need to alleviate the debt burdens under which developing countries currently labor. But economic recovery and growth will also be hastened by directing resources toward strategies designed to put these countries on the long-term path to sustainability. The channelling of funds toward in-

207. Convention on the Recognition and Enforcement of Foreign Arbitral Awards, June 10, 1958, 21 U.S.T. 2517 (entered into force Dec. 29, 1970).

creasing energy efficiency will thus be an important area for investing resources over the next decades. New technologies, permitting the replacement of fossil fuels with clean and renewable sources of energy, are the ultimate goal of environmental and energy policy in developing and developed nations alike.

In light of these considerations, we have proposed an entirely new kind of agreement: the technology-for-nature exchange. This exchange has considerable advantages over its debt-for-nature prototype. Its major advantage is that it promises to bring about large-scale, long-term reform and thus to create structures for encouraging not only lower cost economic development, but also the production of energy by means creating minimal damage to the environment. In its ideal form, it will also advance progress in energy efficiency, an area that is vital to sustainable development. In these ways, a decision to trade technology for nature holds out far more promise than previously contemplated strategies.

The proposed exchange raises some serious economic and ethical questions, and it is also fairly complex. For instance, developed countries may well be under an ethical obligation to transfer technology to developing countries for free or at significant reductions in price. This obligation might be justified by reference to general redistributive goals, environmental concerns, or the view that industrialized countries have profited from technological development producing environmental harms, that such countries benefit from environmental protection in developing countries, and that developing countries should not be placed under special economic disabilities because of environmental damage caused by others. These considerations suggest that at least a heavily discounted transfer of technology may be an ethical obligation of developed countries. Whether or not this is so, a transfer of technology for nature seems to hold out considerable promise.

A transfer of technology for nature requires the cooperation of several parties, all of whom wish to advance different agendas. The arrangement we propose should serve the interests of each party, and the resulting advances in combatting global environmental and developmental problems should benefit all concerned. To some extent such transactions could occur without legal changes, but international and domestic law could both be harnessed to facilitate the process. Technology-for-nature ex-

changes could contribute enormously to resolution of the closely linked problems of environmental protection and economic development.

